Research Report
UKTRP-86-25

RUTTING AND LONGITUDINAL CRACKING AND TEMPERATURE CRACKING A CASE STUDY

(US 23, Greenup County, MP 6.0 to 28.8)

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in cooperation with
Transportation Cabinet
Commonwealth of Kentucky
and the
Federal Highway Administration
U.S. Department of Transportation

November 1986

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
UKTRP-86-25		

4. Title and Subtitle
Rutting and Longitudinal Cracking and Temperature Cracking: A Case Study (US 23, Greenup County, MP 6.0 to 28.5)

5. Report Date
November 1986

6. Performing Organization Code

8. Performing Organization Report No.
UKTRP-86-25

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9. Performing Organization Name and Address
Kentucky Transportation Research Program
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10. Work Unit No. (TRAIS)

11. Contract or Grant No.
Federal-aid Task Order 23

12. Sponsoring Agency Name and Address
Kentucky Transportation Cabinet
State Office Building
Frankfort, Kentucky 40622

13. Type of Report and Period Covered

14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

US 23, Greenup County, Ashland-South Shore, developed rutting and transverse and longitudinal cracking. The pavement was about 14 years old and had served heavy trucks. Road Rater tests, crack surveys, and various inspections had been made prior to the fall of 1985. Inspection and a report by KTRP led to further evaluation, examination internally by trenching, and additional tests and surveys. This report combines pertinent facts and records. It includes recommendations for overlayment.

17. Key Words
Rutting
Cracking
Temperature
Shear

18. Distribution Statement
Unlimited with approval of
Kentucky Transportation Cabinet

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	29	

INTRODUCTION

On October 10, 1985, a familiarization trip to US 23, Ashland to South Shore (opposite Portsmouth) (a location map is shown in Figure 1), resulted in a memorandum report dated November 8, 1985 (1). The memorandum related the following: "Two types of defects were obvious: rutting and transverse cracking." Later, in regard to transverse cracking, it said: "It is theorized that the cracking interval is governed by the tensile strength of the pavement at the first onset of critical shrinkage. Shrinkage, here, is due mostly to thermal contractions."

Both rutting and cracking are systematic and may be analyzed. Rutting depths may be modeled by a computer program (2). The crack frequency ranged from 16 to 57 per mile (330- to 92.6-foot interval).

Road Rater tests had been made September 16, 1984. Overlay requirements to extend the service life 8 additional years were submitted November 30, 1984. Those analyses were extended to 20-year additional service life, and that information was forwarded with the memo report package of November 8, 1985.

The FHWA Pavement Rehabilitation and Design Team was invited to visit the site on November 13-14, 1985. All memoranda and reports mentioned above were available to members of the team at a briefing the evening before touring the roadway. Following receipt of the FHWA report (3), the pavement was trenched at two sites to examine the exposed cross section and to assess internal damage and deterioration.

Field CBR´s were determined, samples were obtained, and laboratory CBR´s and moduli and creep tests were performed. Six cores (4-inch diameter) were obtained from each of the ten design sections by the Division of Materials; four cores of each set were consigned to the Kentucky Transportation Research Program (KTRP). Later, a Road Rater survey was conducted; further crack frequency surveys were undertaken; and data were analyzed and assembled for this report.

Others had studied the pavement from the standpoint of roughness, overlay requirements, full-width patching, chip seals, and crack-filling. Parts of the project had received patching, and a large portion had been treated with one or more applications of an elastomeric

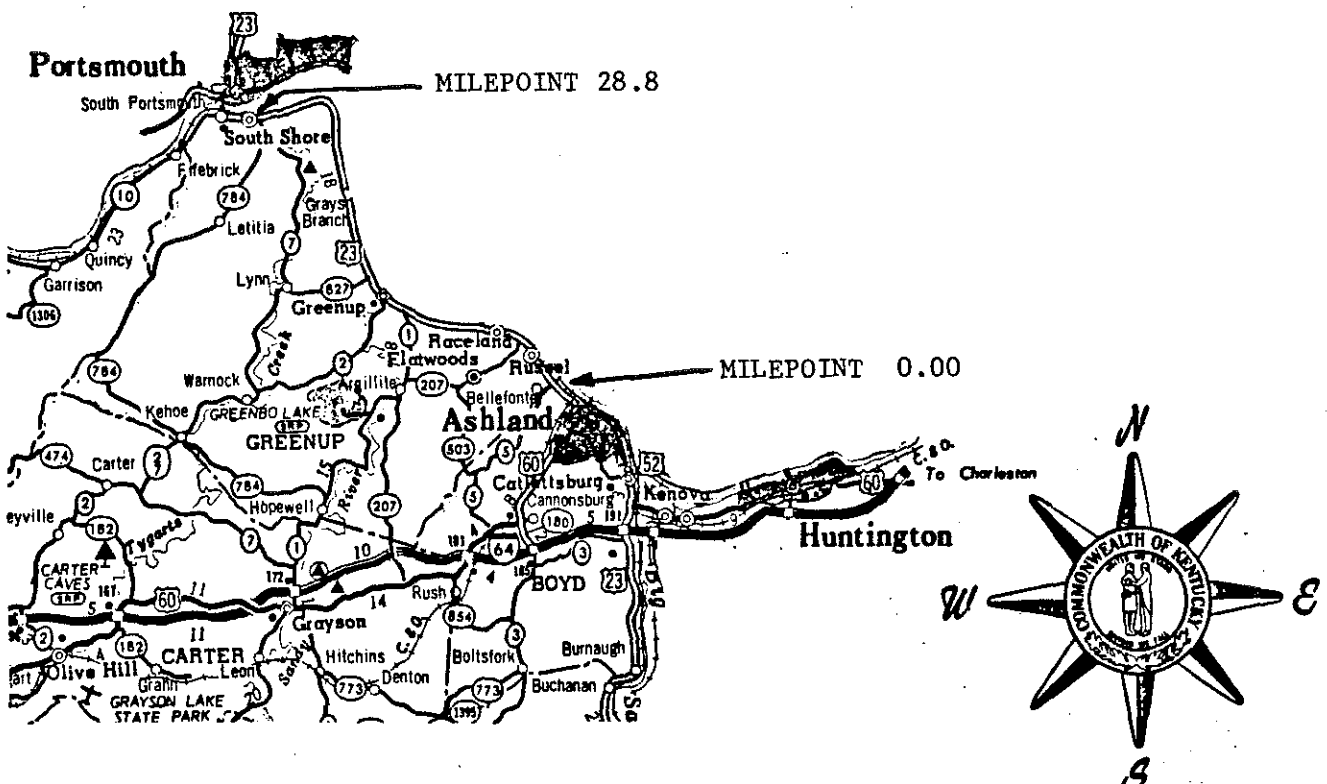

Figure 1. Project Location Map.

asphalt and chip seal.

The section from KY 827 (MP 12.605) to KY 3116 (MP 17.520), southbound lanes only, were advertised for bids for bituminous resurfacing to be received September 19, 1986. The structural analysis indicated that 1.5 inches would suffice for a 20-year design (7.2×10^6 EAL´s).

The northbound section had been advertised earlier and was awarded to Standard Materials, Inc., on August 7, 1986. The initial paving contracts for this section of road were awarded in 1972, 1973, and 1974. The pavements are 12 to 14 years old.

FHWA PAVEMENT REHABILITATION AND DESIGN TEAM

The FHWA Pavement Rehabilitation and Design Team recommended that trenching be performed at two or more sites (3). This was in recognition of the procedure used effectively in Kentucky on several previous occasions (most recently on the southern portion of the Purchase Parkway) (4). Trenching was performed on December 12, 1985. Highway district forces did the sawing and excavations and otherwise assisted KTRP investigators.

FIELD AND LABORATORY TESTS

ROAD RATER TESTS

As mentioned previously, Road Rater tests had been performed on September 26, 1984; and overlay requirements to extend service life 8 additional years had been submitted November 30, 1984. Those analyses were extended to 20-year additional service life (based on traffic forecasts and estimates of EWL´s furnished by the Division of Design) and submitted with the package report of November 8, 1985. New tests were ordered after the meeting with the FHWA team (November 13-14, 1985) and a tour of the project. Those Road Rater tests were performed on December 4-6, 1985. The results from analyses of those tests were reported on March 31, 1986 (5). Full advantage was made of resilient moduli tests on cores obtained by the Division of Materials and in situ CBR's measured in the two trenched sites as the layers were uncovered. Samples of asphaltic concrete from the trenches and bag samples of dense-graded aggregate (DGA) and subgrade soil also had been obtained. Laboratory CBR's were determined. The report of March 31 remains final and unchanged. The procedures employed and the basis for the structural analysis of pavement structures are described subsequently under STRUCTURAL ANALYSES AND OVERLAY REQUIREMENTS.

TRANSVERSE INSPECTION TRENCHES

Two sites were trenched on December 12, 1985. The first was at MP 14.0 (Section E) (Figure 2), and the second was at MP 7.3 (Section A) (Figure 3). Both were on the outer northbound lane. Section E contained limestone throughout. Section A was slag. The slag DGA had set (weakly hydraulic) (see Figure 3e).

Saw cuts were made through the asphaltic concrete. A backhoe was used to remove the slabs and DGA.

There was a significant amount of fine material above the DGA base when the asphaltic concrete was removed. The origin of this material is not known. It may have been dust from the sawing, it may have existed at the time of construction, or it may have been generated in place by grinding (percussion and/or slippage) between the base aggregate and the bottom surface of the asphaltic concrete. The effect of such material on Road Rater deflections is magnifying -- that is, greater deflections signify less stiffness of the pavement and, therefore, lower moduli of the layers. A lower CBR of the soil would be deduced.

RUTTING MEASUREMENTS

At Sites 1 and 2 (MP 14.0 and 7.3, respectively), rutting measurements were made at the surface, at the asphalt-dense-graded aggregate interface, and at the dense-graded aggregate-subgrade interface. Offsets from stringlines were used to determine rut depths. Figure 4a shows the measured rutting at Site 1. Surface rutting in the inside wheel track was 1.4 inches. The asphalt layers in the inside wheel track had thinned to 5.5 inches. Rutting in the subgrade averaged approximately 1.0 inch.

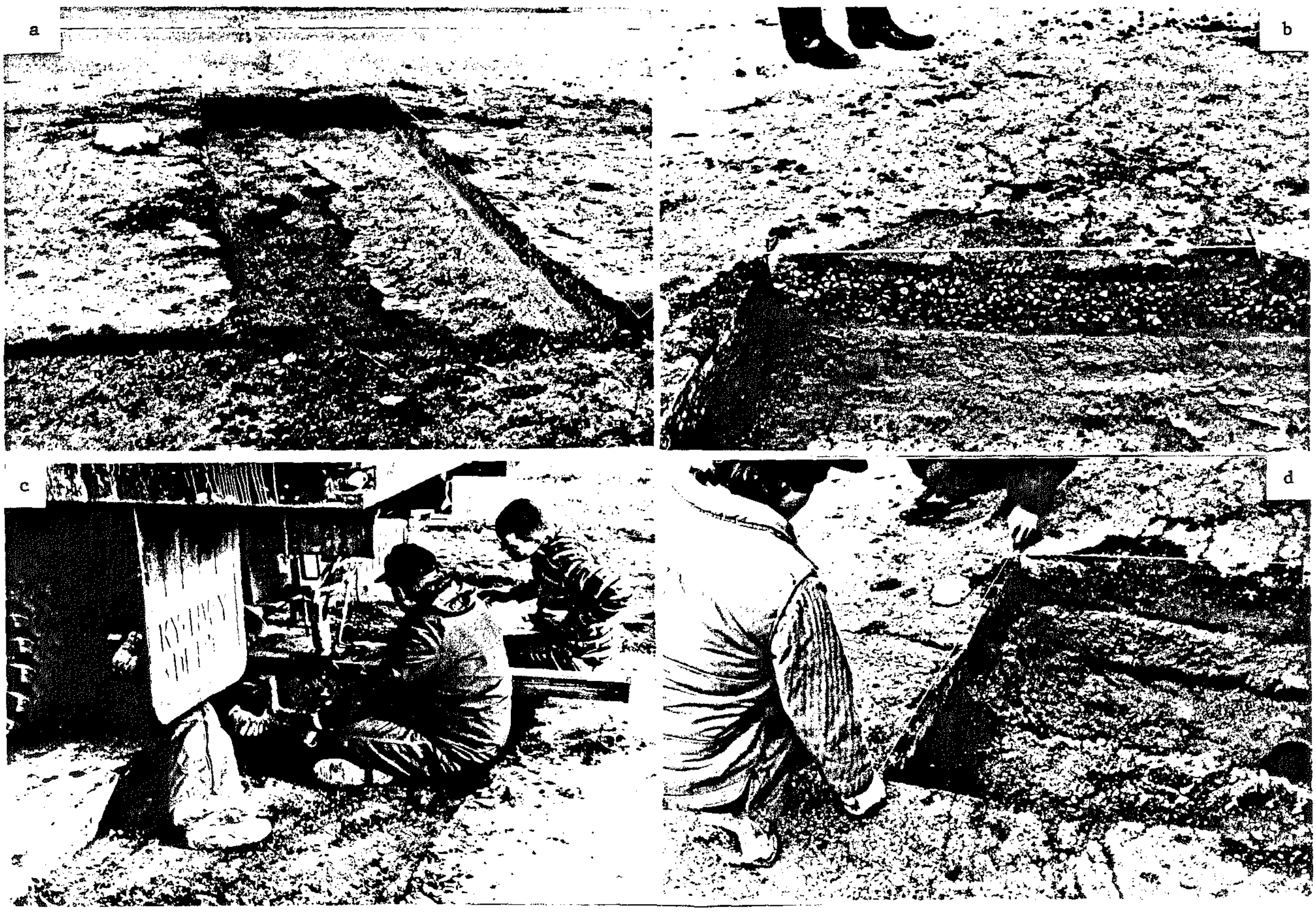

Figure 2. Site 1, MP 14.0, Northbound, Trenched December 12, 1985.

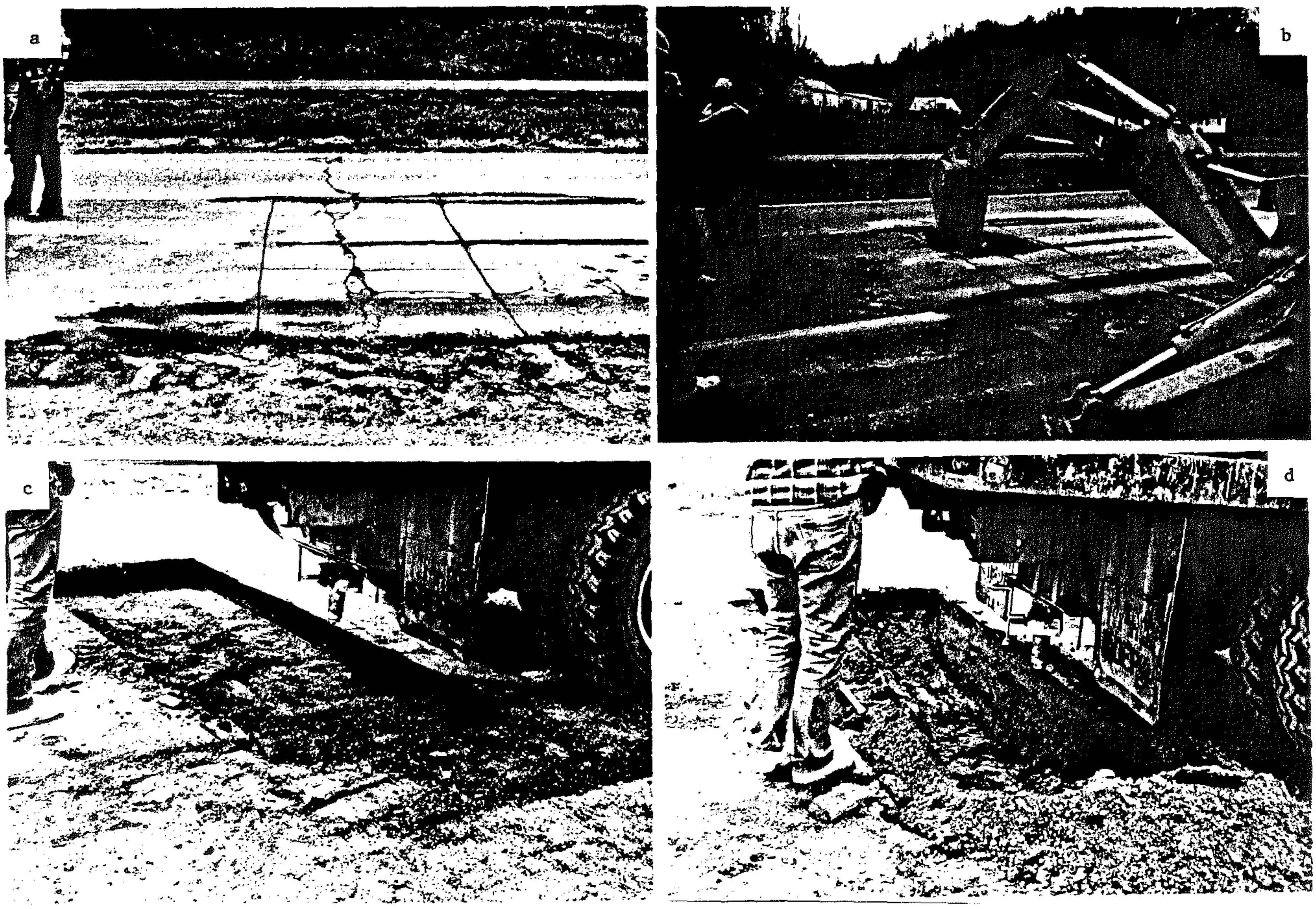

Figure 3. Site 2, MP 7.3, Northbound, Trenched December 12, 1985.

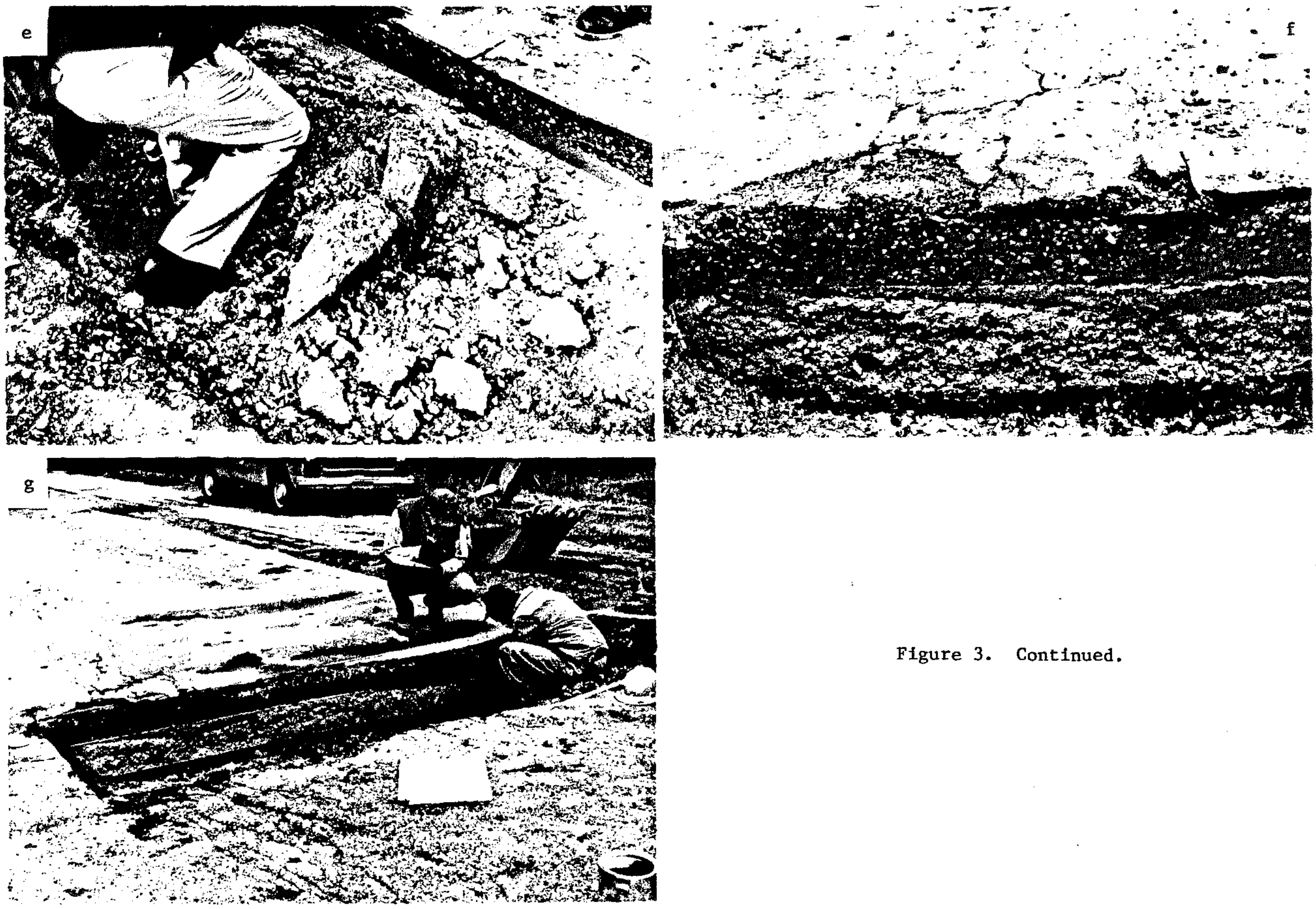

Figure 3. Continued.

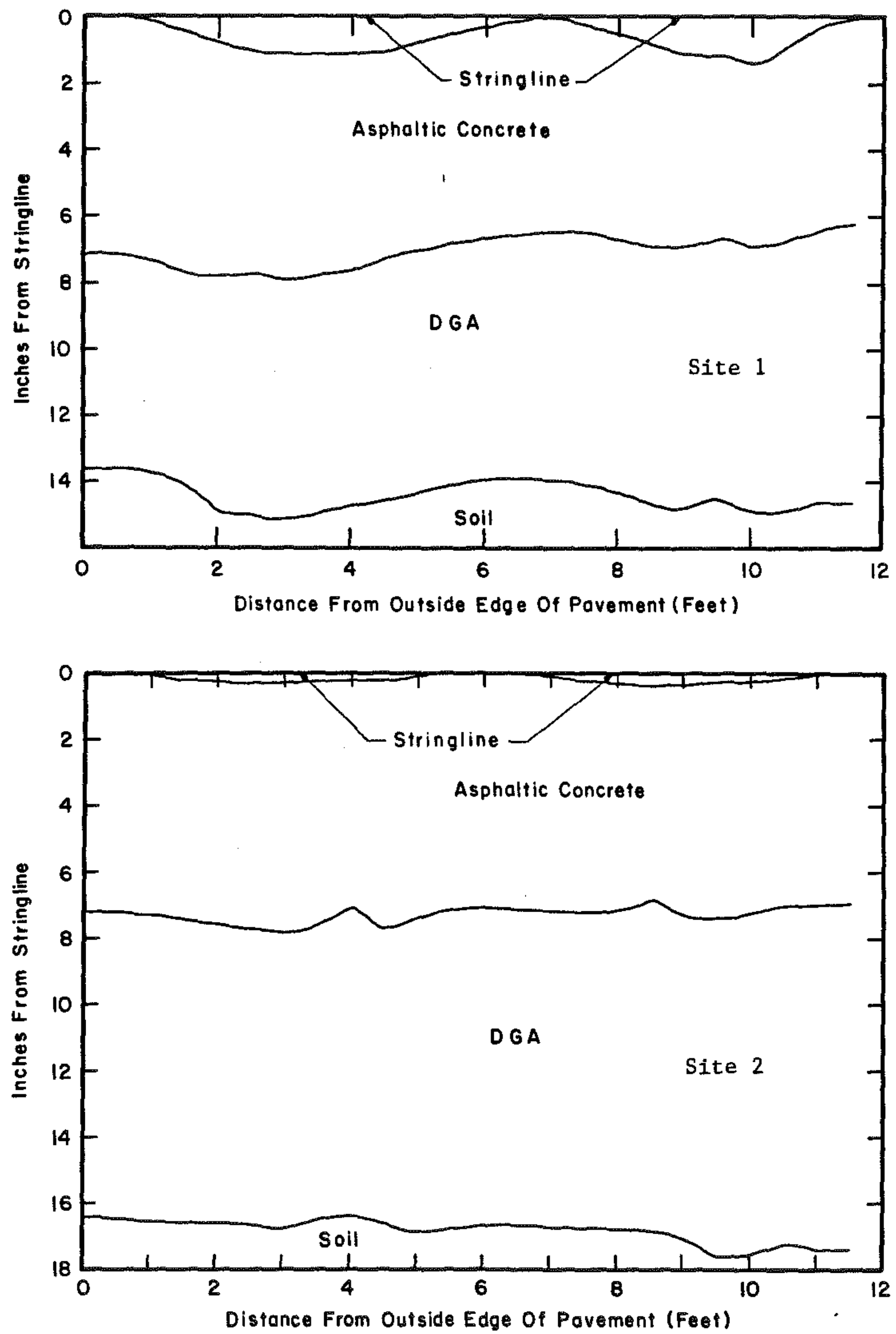

Figure 4. Rutting Measured as Deviations from Stringline: (a) Site 1 and (b) Site 2.

At Site 2, surface rutting was less than 0.5 inch. However, the asphaltic concrete-dense-graded aggregate interface had rutted 0.8 inch in the outside wheel track, and the subgrade had rutted 0.6 inch in the inside wheel track. Figure 4b shows the measured rutting at Site 2.

IN SITU AND LABORATORY CBR´S

Field CBR values obained on December 12, 1985 are as follows:

LOCATION	MATERIAL	CBR
MP 7.3	DGA	47
MP 7.3	Soil	14
MP 14.0	DGA	67
MP 14.0	Soil	7

Bag samples obtained on December 12, and stored at the laboratory until February 25, were recompacted at their natural moisture contents and penetrated according to CBR test procedures (without drying or soaking). The CBR´s obtained are as follows:

LOCATION	MATERIAL	CBR	NATURAL MOISTURE CONTENT (%)	RECOMPACTED DRY DENSITY (lbs/cu ft)
MP 7.3	DGA (Slag)	226	12.9	114.9
MP 7.3	Soil	34	12.1	121.4
MP 14.0	DGA (Limestone)	205	5.1	141.2
MP 14.0	Soil	19	12.6	122.6

CORES: UNIT WEIGHTS AND STABILITIES

Eight or nine cores were obtained from each design section. Two per set were tested for unit weight, stability, resilient modulus of elasticity, and rutting potential. These data are shown in Table 1. Also shown are the similitude estimates of rut depths. Unfortunately, the real depths were measured only at the trenched sites (MP 7.3 and 14.0).

Unit weights in the all-slag sections were in the order of 135 pounds per cubic foot. Weights in the all-limestone sections were approximately 145 pounds per cubic foot. Stabilities were in the order of 3,000 pounds.

No deficiencies of the sections are attributable to the properties of materials shown in Table 1.

Other stability data are listed in Table 2. Specimens reported were cored from slabs of asphaltic concrete excavated from the trenched sites.

RUTTING SUSCEPTIBILITY AND DYNAMIC MODULUS

Resilient modulus and rutting potential were determined on 19 pavement cores. The cores were tested in compression at 1/2 cycle per second at 70°F. Results are summarized in Table 1.

In most cases, the modulus values are high. Four of the cores (A-3, A-5, E-3, and H-2) had a modulus value exceeding 1,000,000 psi. Only two specimens had moduli less than 480,000 psi (normally, the assumed value for asphaltic concrete at 70°F). These two specimens were I-4 and C-4.

It is assumed these high modulus values resulted from a highly oxidized and very stiff asphaltic cement. However, the viscosity of the asphaltic cement was not measured.

There was no apparent correlation between modulus and rutting potential. It would be expected that after 1,000 cycles of loading, the rutting strain for a normal asphalt mixture would be in the range of 0.04 to 0.06 inch per inch. However, 10 of the 19 specimens had greater values. It is possible these specimens were tested in a "post-failure" condition and that small shear surfaces were present in the material. However, this is not confirmed by other tests for rigidity and stability.

It should be noted that each test specimen was composed of surface, binder, and some base mixture. Therefore, it was not possible to

TABLE 1. CORE LOG AND PROPERTIES

CORE	MILE-POINT	OFFSET	UNIT WEIGHT (lb/cu ft)	STABILITY (lb)	MODULUS (M_r) (ksi)	RUTTING (in./in./ 1,000 cycles)	CALCULATED RUT DEPTH (in.)
A-1	7.4	5'5"	132.7	3,133			
1	7.4	5'5"	(Drilled thru Crack)				
A-2	7.4	6'0"	133.1	3,186			
A-3	3.9	5'0"	137.2	4,183	1,440.4	0.05430	1.40
2	3.9	5'0"					
A-4	3.9	5'0"	138.3	4,083			
3	5.0	4'0"					
4	5.0	3'0"					
A-5	5.9	4'10"	134.4	3,438	1,030.0	0.02131	1.31
A-6	5.9	2'9"	134.6	3,486			
B-1	8.4	2'3"	136.0	3,814	811.6	0.01133	1.44
B-2	8.4	2'3"	137.1	3,822			
5	8.4	2'3"					
B-3	9.4	3'2"	136.3	3,530			
B-4	9.4	3'2"	138.4	3,473	658.9	—	1.44
6	9.4	3'2"					
B-5	10.2	2'0"	133.8	2,776			
B-6	10.2	2'9"	133.6	2,784			
7	10.2	2'4"					
C-1	11.1	4'0"	137.8	3,028			
C-2	11.1	4'0"	139.7	2,935			
8	11.1	4'4"					
C-3	12.0	6'4"	136.4	2,998			
C-4	12.0	6'0"	137.7	2,890	339.4	—	1.26
9	12.0	2'5"					
C-5	12.4	3'9"	140.7	3,415			
C-6	12.4	3'9"	139.4	3,245	493.7	0.13600	1.26
D-1	13.0	3'8"	146.0	4,931			
D-2	13.0	3'8"	146.1	5,871			
10	13.0	3'8"					
D-3	14.4	3'6"	144.6	2,893	725.2	0.07869	1.27
D-4	14.4	3'2"	146.4	3,025			
11	14.4	3'3"					
12	14.4	2'0"					
E-1	15.0	4'1"	147.1	3,040			
E-2	15.0	4'11"	147.1	3,039			
13	15.0	4'9"					
E-3	16.0	3'0"	148.0	3,348	1,067.5	0.02720	1.07
E-4	16.0	6'7"	147.5	3,290	803.5	0.06791	1.07
4	16.0	5'5"					
15	16.0	2'10"					
E-5	17.2	3'11"	148.6	3,168			
E-6	17.2	6'2"	146.6	3,055			
16	17.2	5'6"					
F-1	18.0	5'8"	137.0	2,897	701.9	0.10630	1.02
F-2	18.0	5'6"	135.4	2,887			
17	18.0	5'4"					
F-3	19.0	3'2"	136.6	2,598			
F-4	19.0	6'3"	132.4	2,692			
18	19.0	3'5"					
F-5	20.1	2'9"	147.5	3,240			
F-6	20.1	6'0"	145.4	3,337	604.6	0.12880	1.02
19	20.5	4'10"					
G-1	20.5	3'8"	147.3	3,115			
G-2	20.5	6'5"	146.6	3,318			
20	20.5	4'11"					
G-3	21.5	2'8"	147.3	3,140	630.7	0.07953	1.02
G-4	21.5	7'2"	145.7	2,962			
21	21.8	5'1"					
G-5	21.8	3'11"	148.8	3,197	991.1	0.12440	1.02
G-6	21.8	7'0"	145.8	3,012			
22	22.7	4'1"					
H-1	22.7	6'9"	135.9	3,030			
H-2	22.7	6'5"	133.7	2,981	1,087.9	0.02005	1.02
23	23.0	4'5"					
H-3	23.0	4'5"	137.7	2,980	824.0	0.08404	1.25
H-4	23.0	4'6"	135.0	3,010			
H-5	24.2	4'7"	140.5	3,098			
H-6	24.2	4'10"	139.4	3,064			
I-1	25.3	4'0"	140.5	3,041	485.4	0.04628	1.26
I-2	25.3	4'4"	138.5	2,998			
I-3	26.0	3'8"	139.0	2,962			
I-4	26.0	3'8"	139.1	2,874	289.8	0.04106	1.26
24	26.0	3'10"					
I-5	26.7	2'5"	139.8	3,072			
I-6	26.7	2'6"	139.9	3,165			
J-1	27.4	4'0"	140.3	3,496	576.0	0.10540	1.33
J-2	27.4	4'2"	141.8	3,512	481.0	0.11990	1.33
25	27.4	4'7"					
J-3	28.1	3'8"	140.0	3,443			
J-4	28.1	3'10"	138.1	3,503			
26	28.1	6'8"					
J-5	28.6	3'9"	136.3	2,994			
J-6	28.6	3'10"	143.7	3,180			
27	28.6	2'0"					

TABLE 2. OTHER STABILITY TESTS

IDENTIFICATION	TYPE	STABILITY (pounds)
Site 1 (Sample A)	Surface & Binder	2,500
Site 1 (Sample A)	Base	2,372
Site 1 (Sample B)	Surface & Binder	2,142
Site 1 (Sample B)	Base	2,200
Site 2 (Sample A)	Binder	3,402
Site 2 (Sample A)	Base	1,931
Site 2 (Sample B)	Binder	3,311
Site 2 (Sample B)	Base	1,692

TABLE 3. SUMMARY OF CRACK INTERVAL SURVEY

	DESIGN SECTION TERMINI		CRACK SURVEY TERMINI		AVERAGE CRACK INTERVALS SOUTHBOUND LANE		AVERAGE CRACK INTERVALS NORTHBOUND LANE	
DESIGN SECTION	BEGINNING MILEPOINT	ENDING MILEPOINT	BEGINNING MILEPOINT	ENDING MILEPOINT	NUMBER OF CRACKS	AVERAGE INTERVAL (ft)	NUMBER OF CRACKS	AVERAGE INTERVAL (ft)
A	3.1	7.7	7.000	7.189	18	55	13	38(a)
B	7.7	10.7	9.000	9.189	16	62	15	43(b)
C	10.7	12.6	12.000	12.189	12	83	—	—
D	12.6	14.7	14.000	14.189	15	67	15	67
E	14.7	17.7	16.000	16.189	16	62	15	67
F	17.7	20.3	19.000	19.189	—	—	14	71
G	20.3	22.4	21.000	21.189	—	—	—	—
H	22.4	25.1	23.000	23.189	18	55	22	45
I	25.1	26.8	26.000	26.189	30	33	15	67
J	26.8	28.8	28.000	28.189	27	27	25	40

Note: a) based on 500-foot sample interval
b) based on 650-foot sample interval

determine which of those layers was weakest. Consequently, modulus and rutting values are for a composite of all the asphalt layers.

Cores obtained from Site 1 (MP 14.0) and Site 2 (MP 7.3) were separated at the interface between the binder and the base mixtures. Marshall stability tests were performed on the combined surface and binder layers and on the base layer at Site 1. Stability values ranged from 2,142 pounds to 2,500 pounds.

At Site 2, the surface mixture was not tested; however, the binder mixture and the base mixture were tested separately. The binder mixture at Site 2 had stability values over 3,300 pounds for both specimens. However, the two base specimens averaged just over 1,800 pounds. A summary of these Marshall stability data is in Table 2 (Note: Compare with Table 3). Rutting susceptibility was translated into an estimate of total rut depth according to a computer program designated PAVERUT (2). Those estimates are listed in Table 1 also.

ANALYSES OF CRACKING

No deficiencies of materials or structural strengths were discovered. The pavement performed adequately. Susceptibility to temperature cracking may be an insidious freak of nature. Other cracking is considered to be more or less normal for a spent or exhausted pavement. "Other cracking" alludes to the longitudinal load-associated cracks along the edges of wheelpaths (sometimes in the wheelpaths). This pattern of cracking was first observed on the Watterson Expressway (6, 7) before the first resurfacing. Those cracks were not due to reverse bending outside the wheelpaths, but were at the very edge of the depressed wheelpath. They seemed to portray a direct punching-shearing situation. The wheelpath was more-or-less flat but depressed and was about 30 inches across. This pattern has been recognized elsewhere (Purchase Parkway, I 64 at MP 164, and US 60 from Olive Hill eastward) (see Figure 5) (8, 9).

The shear mode is evident. Maximum shear tends to occur at a depth equal to one-third the radius of the loaded area. Assuming the diameter to be 30 inches (the approximate width of the rutted wheelpaths), the

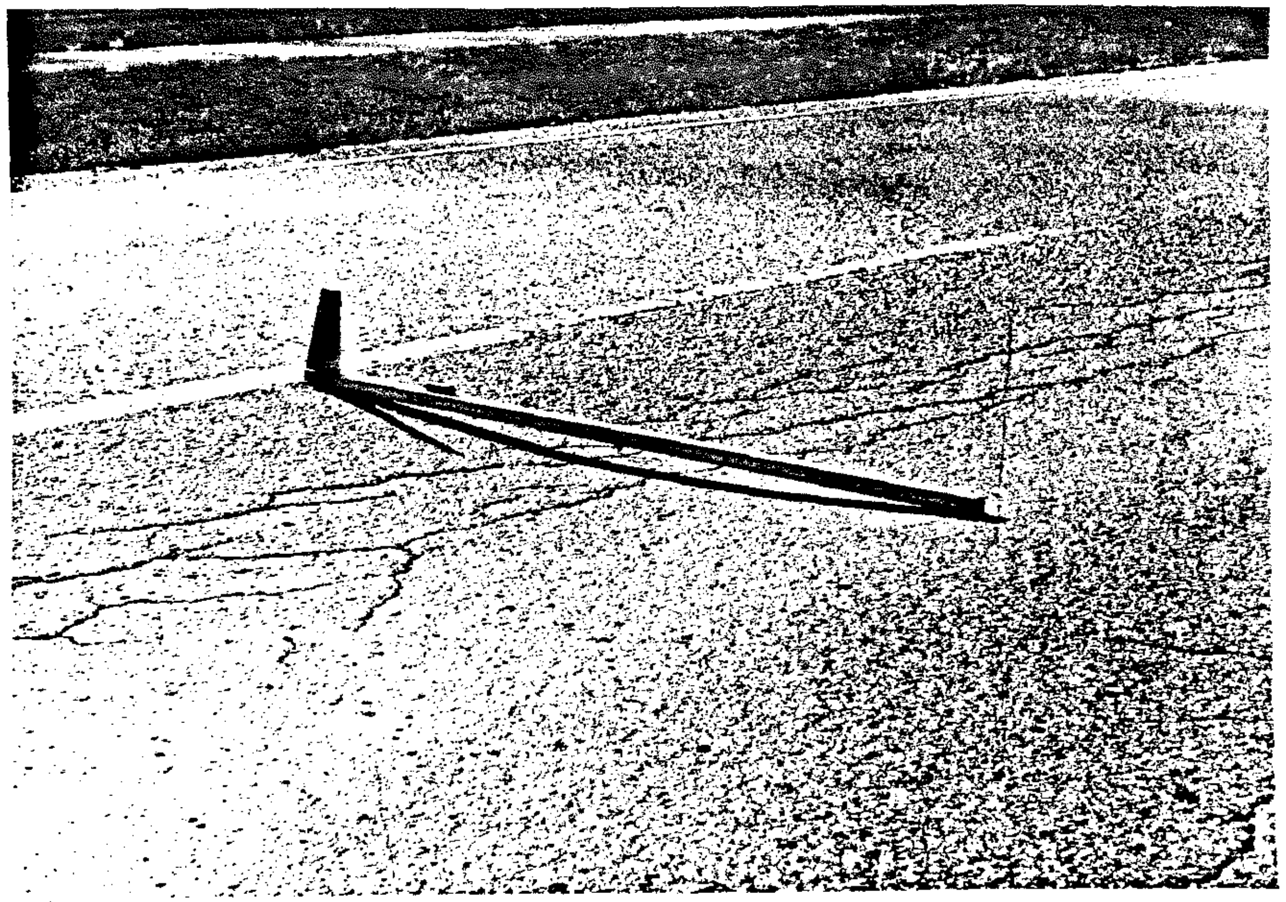

Figure 5. Typical Cracking Pattern Accompanying Rutting in Wheelpath on I 64, MP 164, December 4, 1979 (8, 9).

depth of maximum shear would be 5 inches. Punching shear may suffice to explain longitudinal cracking at the edges of the wheelpaths. Maximum shear may explain eventual checkering and map cracking within the wheelpaths. Kneading shear in the wheelpaths together with punching shear at the edges progresses little by little. These concepts are illustrated diagrammatically in Figure 6. A crushed rock base may be as strong after deformation as it was before deformation, and the foundation soil may not be critically weakened until slip planes develop or swelling due to water infiltration occurs. An example of early failure exhibiting a longitudinal crack pattern is shown in Figure 7. There, failure occurred within a few months of service, it was attributed to gelled clay in the foundation (site was trenched and evaluated). Subsequent overlayment hid and adequately bridged over the short section involved. Heavy hauling may have abated also.

Some witnesses at the trenched sites on US 23 expected to find the transverse cracks at the surface also extending through the DGA base. If a crack had existed in the slag DGA, it would not have escaped notice because the slag base was somewhat monolithic and came up in slabs and chunks. None of the edges showed signs of staining or darkening due to infiltration.

Further explanation of the temperature cracking phenomena is contained in the memorandum report, November 8, 1985, which was presented as part of a package report to the FHWA review team (1). It is theorized that the crack interval is governed by the tensile strength of the pavement at the first onset of critical shrinkage. Shrinkage, here, is due to thermal contraction. Temperature cracking is probably more the rule than the exception in Kentucky. The spacing varies from place to place, and the widths of cracks vary.

The horizontal tensile force in a pavement is $F_t = \sigma A$, where σ = tensile stress, A = say 1 square foot or 144 square inches. The resistance to sliding (that is the force of friction) is given by F_t = fWL, where W is the weight in pounds of cubic foot of pavement, f is approximately 1, and L is the length of pavement. Equating forces and substituting:

$$\sigma A = fWL$$

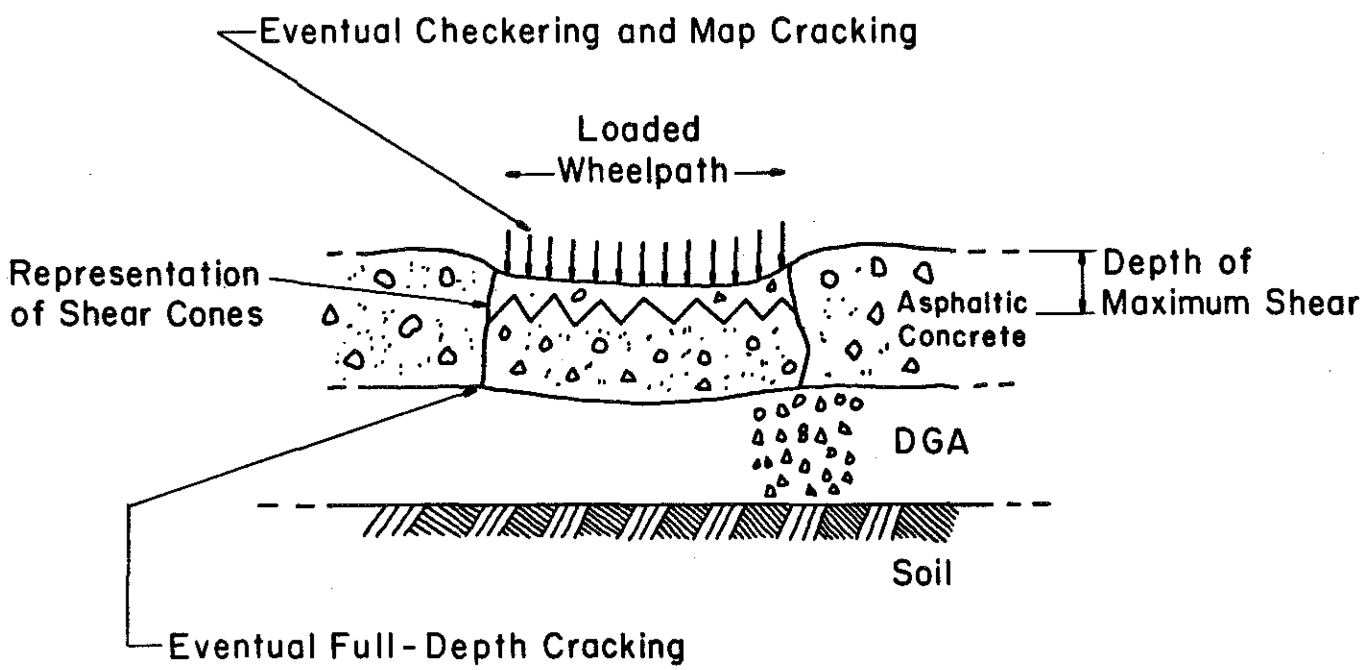

Figure 6. Schematic Diagram Illustrating Conceptual Modes of Shear Failure Accompanying Rutting. Punching shear occurs across the wheelpath. Kneading shear occurs within the wheelpath and eventually leads to checkering and blocking out.

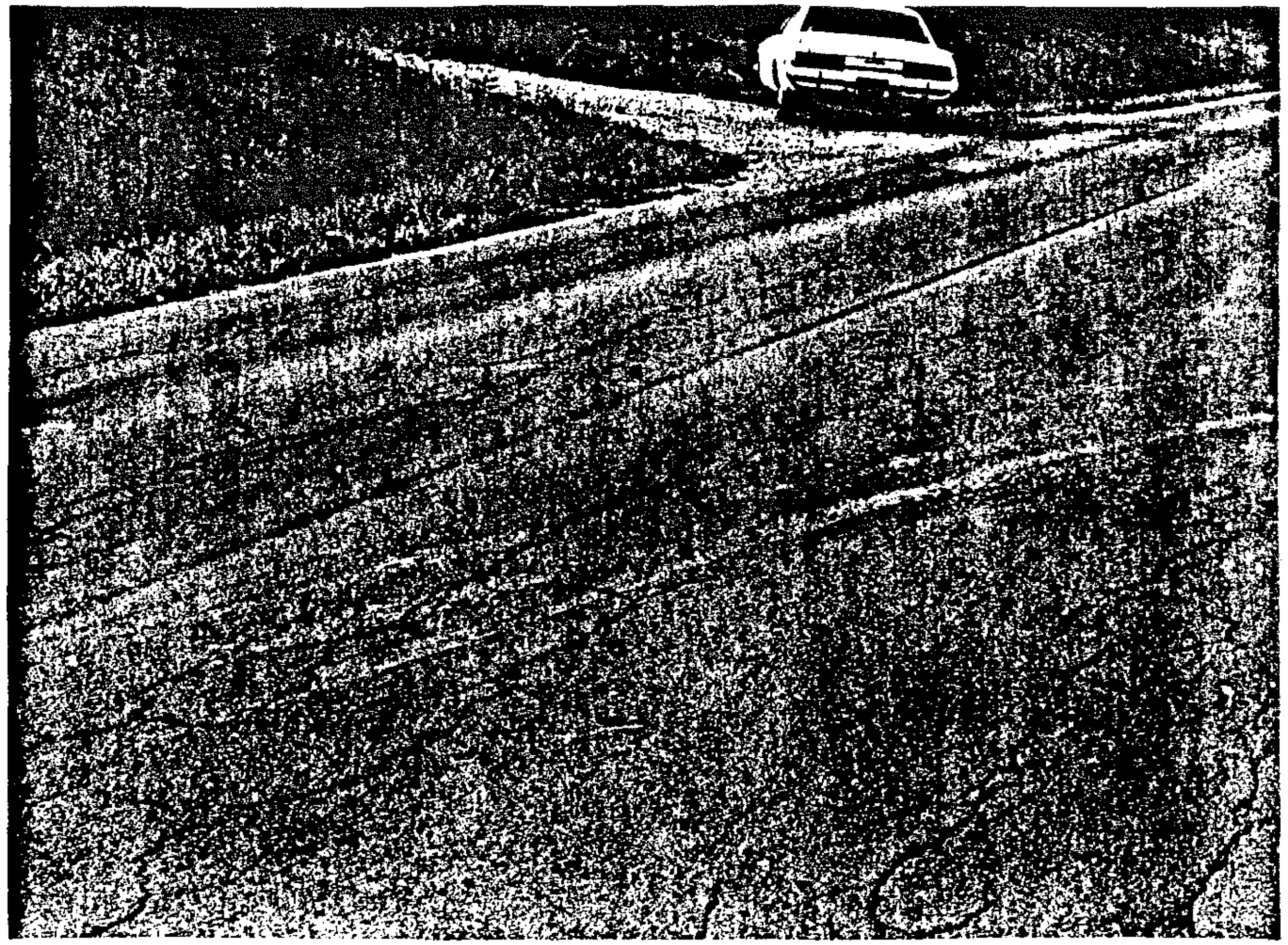

Figure 7. US 62, Harrison County, SP 19-112-10C1, September 19, 1979, Wheelpaths Cracking (Longitudinal), 8.5 Inches of Asphaltic Concrete. Cracking occurred about 6 months after construction. There was heavy hauling in both directions. Section shown above was trenched later in 1979. The soil underneath was a gelled clay that gave only spongy support. Cracks were recognized as the punching-shear mode of failure.

or

$L = \sigma$ (numerically).

Therefore, the maximum crack spacing is 2L, and L, in feet, is numerically equal to the tensile strength of the pavement in pounds per square inch (psi).

Wide cracks indicate either permanent shrinkage or in-filling and reclosure. Reclosure on debris would tend to crush material or cause buckling. There was a strong tendency for necking down at joints otherwise well filled. This is illustrated in Figure 2a. A few neat, sharp-edged, narrow cracks were observed. They may have formed much more recently than others.

A general thesis may be stated as follows: the interval (distance) between cracks is determined (governed) by the tensile strength of the asphaltic concrete at the time of critical contraction and (or) shrinkage. Usually, temperature cracks are not very wide or obvious. The widths of the cracks, if they could be ascertained truly, could be summed over a mile section of roadway and an estimate of shrinkage could be obtained.

The crack intervals (see Table 3) are not sufficiently discrete to distinguish between slag and limestone sections.

STRUCTURAL ANALYSES AND OVERLAY REQUIREMENTS

Four-inch diameter bituminous cores were obtained by the Division of Materials for evaluation by the KTRP staff. Six cores were obtained from each design section. The cores were measured for thickness and then sawed to approximately 2-1/2 x 2-1/2 inch squares and varying lengths, depending upon the constructed thickness of the sections. Elastic moduli were obtained for each prism at 70°F by fundamental frequency method (ASTM C 215) and adjusted to reflect a Poisson's ratio of 0.4 for the bituminous material.

The 2-1/2-inch prisms were then cored to a nominal diameter of 2 inches. Resilient moduli were obtained for two cores for each design section at 70°F and a frequency of one-half Hertz. A semi-log relationship (see Figure 8) between elastic modulus and frequency was then developed for each design section using the moduli obtained from fundamental frequency and resilient modulus tests. Elastic moduli at 25 Hertz were estimated from the graphical relationship.

Road Rater deflections were obtained for the various design sections, and field CBR's were obtained on the dense-graded aggregate (DGA) base and the soil subgrade in two trenched areas (Design Sections A and D.) The measured CBR's were compared to and confirmed by in-place CBR's. Corrections for deflection readings were made on the basis of temperatures measured during trenching operations and the five-day air temperatures obtained prior to the dates deflection readings were taken.

During trenching operations, temperatures were measured on the surface with an infrared temperature sensing device. Holes were drilled to approximately 2, 4, and 6 inches in depth and filled with water and allowed to stabilize. The temperature in the holes were measured with a standard thermometer. However, water in the drilled holes appeared to stabilize at air temperature. Another method to measure the temperature gradient for the pavement also was empoyed. As workers lifted the asphalt slabs from the trenches, the infrared thermometer was used to measure the temperature at various depths. Using the later method, the temperature gradient in the asphalt was very similar to the temperature gradients observed by Southgate in 1974 (10) and could be directly related to the surface temperature and air temperature. Using the temperature gradient of the asphaltic concrete and the five-day air temperatures prior to the deflection survey, the surface temperatures measured during the deflection survey were adjusted. The adjusted temperatures were used in calculation of the effective layer moduli for each design section.

Elastic layer theory was used to evaluate measured deflections for the purpose of back calculation of effective pavement conditions. Average estimated elastic moduli at 25 Hz were determined for each design section. The Chevron N-layer computer program was used to compute theoretical deflections for the Road Rater loading (600 pounds force) and configuration of the velocity transducers (11) associated with the estimated elastic modulus for the asphaltic concrete

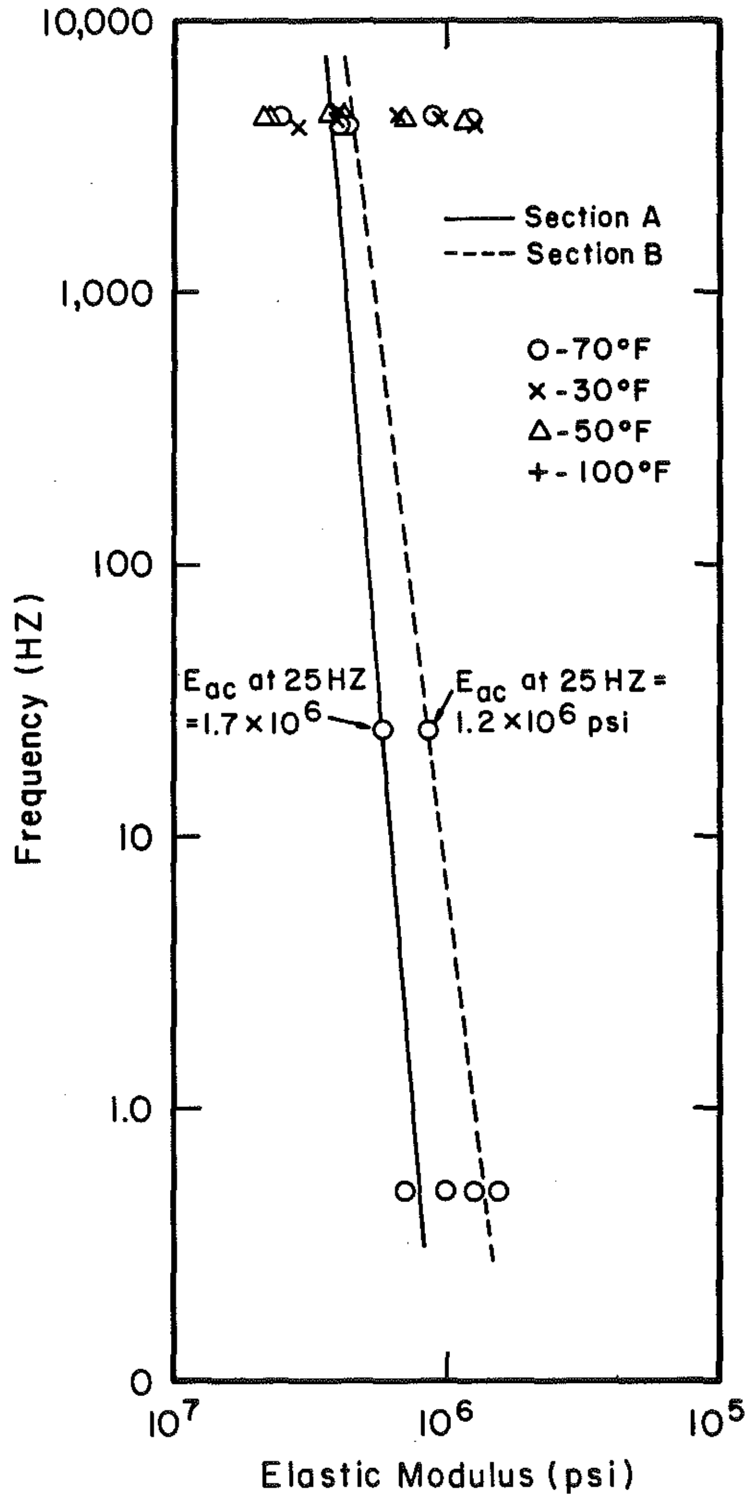

Figure 8. Graphical Translation of Moduli of Elasticity across Frequency Range.

(determined by laboratory analyses) and a range of elastic moduli for the subgrade layer. The modulus of the crushed stone layer was varied as a function of the moduli of layers above and below the crushed stone (12). Simulated deflection measurements were used to determine relationships (for each sensor) describing the change in deflection associated with varying the modulus for the subgrade and also incorporating the previously referenced variation in modulus for the crushed stone layer. Measured deflections were applied to the relationships of simulated deflections to estimate the effective subgrade modulus indicated by each sensor. Estimated subgrade moduli corresponding to each sensor were averaged to estimate a mean subgrade modulus for each test site in terms of the estimated elastic modulus at 25 Hz determined from laboratory analysis. These values were compared to measured CBR's determined in place and from samples in the laboratory. The elastic modulus of the crushed stone was estimated on the same basis as previously referenced. Thus, the effective pavement conditions were determined for each of the ten design sections.

The effective elastic modulus at 1/2 Hertz was then used in combination with estimated subgrade modulus determined from deflection tests as input parameters to the Chevron N-layer computer program. The program was used to compute stresses and strains associated with an 18,000-pound axleload for each design section.

Thickness design procedures used in Kentucky for flexible pavements are based on a criterion of limiting strain versus repetitions of an 18,000-pound axle. Critical strains are the tensile strain at the bottom of the asphaltic concrete layer and the vertical compressive strain at the top of the subgrade layers. Critical (design) strains corresponding to the design number of repetitions of an 18,000-pound axle were determined for each design section for both the asphaltic concrete and the subgrade layers.

The Chevron N-layer computer program was used to compute stresses and strains at critical locations (top of subgrade, bottom of asphaltic concrete) for each design section corresponding to the effective pavement condition combined with a range of thicknesses of overlay with asphaltic concrete. The overlay thickness design requirement for each section was determined by matching limiting strain requirements with computed strains for the effective condition plus overlays. This process involved a dual comparison of limiting strain versus computed strain for each critical location -- tensile vertical compressive strain at the top of the subgrade. This procedure is diagrammed in the style of a flow chart in Figure 9.

CONCLUSIONS AND RECOMMENDATIONS

1. Transverse temperature cracks are somewhat benign and innocuous unless they create a bump in the road. Many of the cracks on US 23 have existed a long time -- perhaps from the first year or two after construction. Only recently have they become intolerable. Nominal rutting is rather inoffensive; more rutting becomes less tolerable. Neither of these flaws has devastated the pavement with dips and potholes. Considerable life remains. Overlaying is recommended. Overlays proved successful on the Watterson Expressway (6, 7), Purchase Parkway (4), I 64 (eastern end) (9), and in other similar cases (13, 14). Overlay recommendations were submitted in March (5).

2. Temperature (transverse) cracks probably should not be sealed. The overlay will suffice structurally, but the transverse cracks will reflect through and be unnoticed for a time.

3. Wheelpath cracking has been documented for further analysis by theoreticians.

4. Few, if any, asphaltic concrete pavements are free of (or immune to) temperature cracking (4, 14).

5. Rutting will eventually lead to longitudinal cracking at the edges of and in the wheelpaths (1, 4, 14).

REFERENCES

1. Letter report to C. S. Layson, Assistant State Highway Engineer, from James H. Havens, Associate Director, KTRP, November 8, 1985, Subject: Pavement Inspection Team, C. S. Layson, A. B. Magee, E. B. Drake, J. H. Havens, October 10, 1985, US 23, Ashland-South Shore.

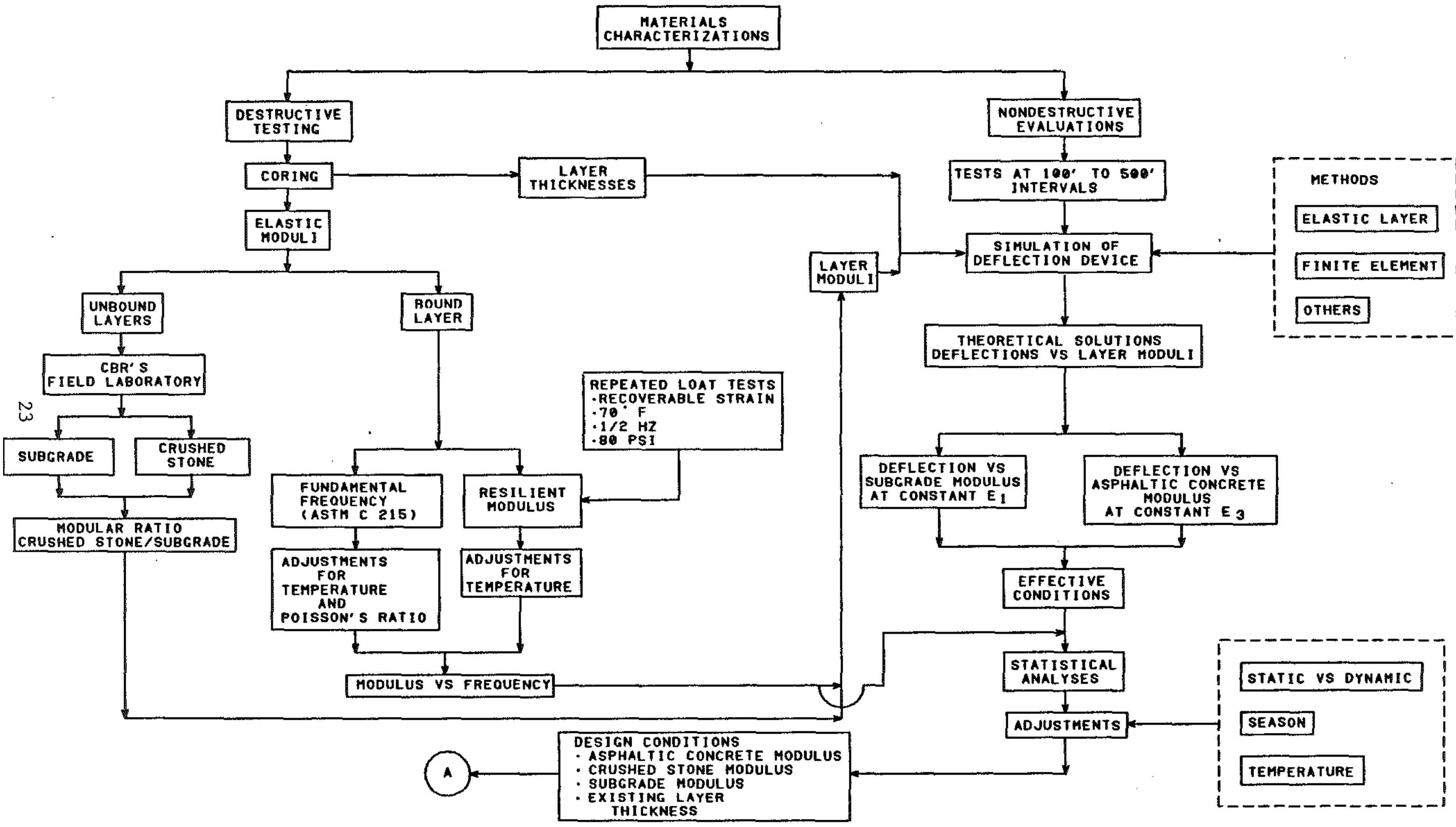

Figure 9. Flow Chart Showing Process of Analyzing Pavement Structures from Road Rater Measurements.

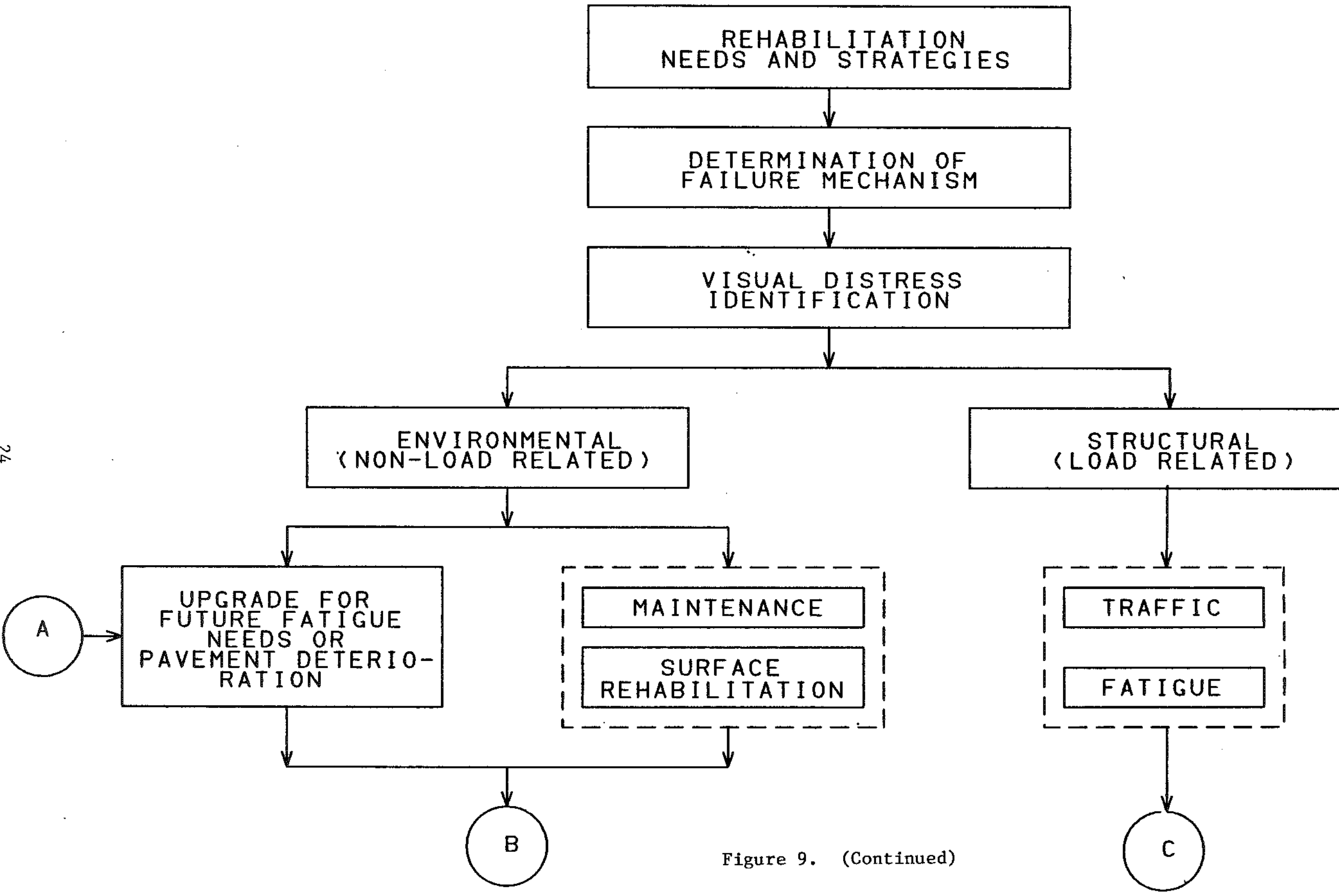

Figure 9. (Continued)

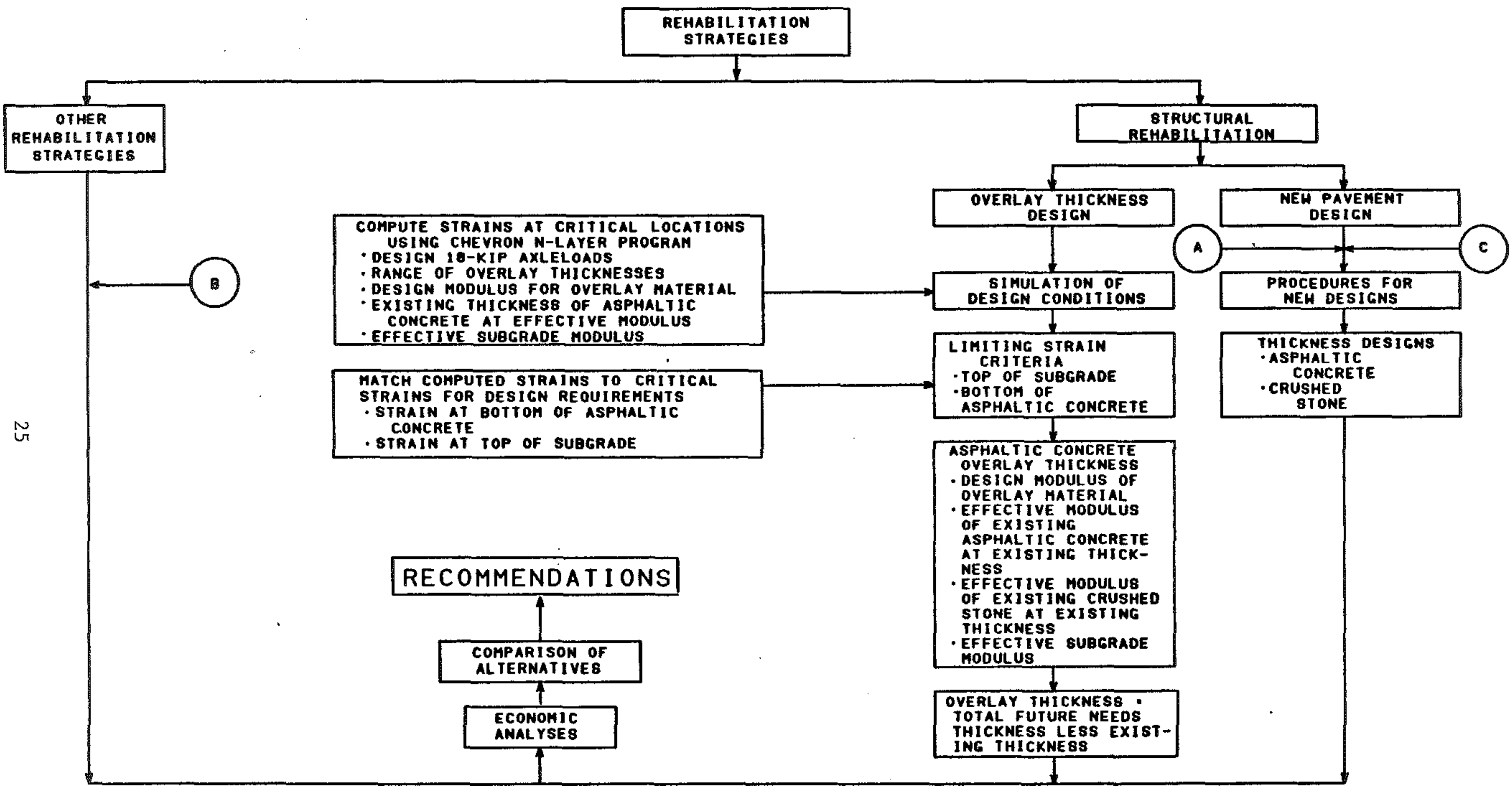

Figure 9. (Continued)

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4. Havens, J. H., "Jackson Purchase Parkway Pavement Study," Research Report UKTRP-84-25, Kentucky Transportation Research Program, University of Kentucky, October 1984.

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9. Sharpe, G. W., and Southgate, H. F., "Overlay Recommendations for I 64: Rowan, Carter, and Boyd Counties, Kentucky," Research Report 551, Bureau of Highways, August 1980.

10. Southgate, H. F., "Temperature Distributions in Asphaltic Concrete Pavements," Research Report 396, Kentucky Department of Transportation, July 1974.

11. Sharpe, G. W., Southgate, H. F., and Deen, R. C., "Pavement Evaluation Using Dynamic Deflections," Record 700, Transportation Research Board, 1979.

12. Deen, R. C., Southgate, H. F., and Sharpe, G. W., "Evaluation of Asphaltic Concrete Pavements for Overlay Design," Research Report UKTRP-83-24, Kentucky Transportation Research Program, College of Engineering, University of Kentucky, October 1983.

13. Memo to W. B. Drake, Assistant State Highway Engineer for Research, from James H. Havens, Director of Research, Kentucky Department of Transportation; Subject: Rutting, Asphaltic Concrete Pavements, September 5, 1978 (Research File P-3-1) (First trenching into full-depth asphaltic concrete, Daniel Boone Parkway, near Thousand Sticks).

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APPENDIX 1

KENTUCKY TRANSPORTATION RESEARCH PROGRAM

UNIVERSITY OF KENTUCKY

College of Engineering
Transportation Research Building
533 South Limestone
Lexington, Kentucky 40506-0043
Telephone: 606-257-4513

November 8, 1985

H-2-89

Mr. C. S. Layson, P.E.
Assistant State Highway Engineer
Bureau of Highways
Department of Transportation
Frankfort, Kentucky 40622

Subject: Pavement Inspection Team; C. S. Layson, A. B. Magee, E. B. Drake, J. H. Havens, October 10, 1985, US23, Ashland-South Shore (Portsmouth).

Dear Mr. Layson:

Two types of defects were obvious: rutting and transverse cracking. The rutting was directly and irrefutably caused by extremely heavy trucks hauling coal to Portsmouth (and beyond). The hauling extends from Louisa and points in Martin, Johnson, and perhaps Floyd Counties. Hauling here was interrupted only by closure of the suspension bridge (for re-cabling, in 1978-1979) at South Shore. The transverse cracking is not associated with loading. A highway bridge crossing Greenup Dam will be opening soon, and coal truck traffic may cross the River at that point rather than at South Shore.

The rutting is systematic and can be modeled by computer programs presently at hand. The pavement structures were tested last year and processed through other programs to determine overlay requirements. Those requirements were in the order of 1.5 inches to extend the service life another eight years. Milling or leveling and wedging would be required to correct the rutting.

Rutting varies along the road and is a maximum of about 1.5 inches. Numerous coal-hauling trucks have plied the road. Each truck makes the rut a little deeper. The deformation (non-recoverable shear) occurs in the upper 3 to 5 inches of the asphaltic concrete. This has been demonstrated by trenching and inspecting exposed cross sections of the pavements. The most recent case was the Purchase Parkway (Ref. Research Report UKTRP-84-28). Just previous to that was US23, just north of Louisa ((Research Report UKTRP-84-1; "Rutting: A Case Study (US23; 1.5 miles north of Louisa)), January 1984. Prior histories are given there also. Coal trucks now are reportedly hauling 60 to 80 tons (payload) per trip. Most recently they caused rutting on a new section of US23, between Lowmansville and Louisa.

Transverse cracking persisted throughout. The frequency ranged between

16 and 57 per mile; thus, the interval ranged between 330 feet and 92.6 feet. It is theorized that the interval is governed by the tensile strength of the pavement at the first onset of critical shrinkage. Shrinkage, here, is due to thermal contraction. Temperature cracking is probably more the rule than the exception in Kentucky. A case in point is the Purchase Parkway (reported in 1984). Of course, the spacing varies from place to place, and the width of the cracks varies.

The horizontal tensile force in a pavement is $F_t = \sigma A$, where σ = tensile stress, A = say 1 sq. ft. or 144 sq. ins. The resistance to sliding (that is the force of friction) is given by $F_t = fWL$, where W is the weight in pounds of a 1-ft cube of pavement and L is the length of pavement. Equating forces:

$$\sigma A = fWL$$
$$A = 144 \text{ sq. ins.}$$
$$W = 144 \text{ lbs/cu.ft.}$$
$$f = \text{approximately } 1$$
$$L = \sigma$$

Therefore, the maximum crack spacing is 2L; and L, in feet, is numerically equal to the tensile strength of the pavement in pounds per square inch (psi).

Sixteen cracks per mile gives a spacing of 330 ft.; L = 165 ft. and σ, therefore, would be 165 psi. Sixty cracks per mile gives a spacing of 88 ft.; L = 44 ft., and σ = 44 psi.

Why is there such a great difference in tensile strength? Shouldn't these pavements have about the same tensile strengths? Yes, they have about the same strengths at low temperatures; but that strength (about 400 psi) is greater than these strengths. Consequently these cracks occurred at more moderate temperatures -- perhaps well above moderate temperatures -- perhaps even warmer temperatures.

It is believed that close-spaced cracks occurred during daily cycling of temperatures in the fall season. The longer-spaced cracks occurred during a cooler period. Differences in properties of the pavements surely influenced the patterns.

Some cracks seemed older and wider than others. The pavements are old enough to present mature crack patterns, but the development of them is lost history.

The pavement is not failing at the cracks. This means that the structure has not been greatly weakened by them or that it needs more overlayment over the cracks. The most significant consideration, therefore, seems to be the problem of reflection cracking of any overlayment. It seems unlikely that any way will be found to prevent the cracks from reflecting through. They might be routed and sealed later if they are considered to be offensive and unsightly. It is important to keep in mind that the purposes of overlayment are to correct for rutting and to extend the service life according to projected traffic.

We could have entitled this report "The Reality of Cracks." Temperature cracking is the principal subject. Expounding further: Are cracks predictable? Yes, they occur almost everywhere unless very soft asphalts are used. Is the spacing of the cracks predictable? Yes, if the tensile strength is known, the equation already cited applies very well. A single reference suffices as an independent, state-of-the-art treatise. It is: "Prediction of Temperature Cracking at Low

Temperatures;" by B. E. Ruth, L. A. K. Bloy, and A. A. Avital; Proceedings, Association of Asphalt Paving Technologists, Vol. 51, 1982.

The section from Sta. 440 to 687 + 48.76 (equals 580 + 73.93 ahead) and to Sta. 851 contains limestone aggregate in the bituminous concretes and in the DGA bases. This appears to be the area where the crack interval was 88 ft. All other sections contained slag in the bituminous base and surface. This is where the close-spacing occurred. Why does slag cause the difference? It has been known for a long time that slags tending to be vesicular absorb oils from the asphalt binder, and that causes drying and hardening of the asphalt. It is not known how much shrinkage accompanies the process. It is possible that some warm temperature fracturing ensues and weakens the tensile properties of the pavement. Otherwise, the crack spacing would or should be about the same as in the limestone sections.

At some cracks, it appeared that "necking down," a phenomenon accompanying ductile fracture, had occurred.

Illustrative photographs are attached hereto.

The all-limestone sections run from Ky 827, down river to Sta. 440. There are two sections downstream (to Sta. 206) which contain limestone in the DGA. Also, there are two sections upstream which contain limestone in the DGA. If these sections are found to have crack-spacing similar to the all-limestone sections, the influence could be attributed commonly to the DGA bases. On the other hand, if the spacings differ, the difference could be attributed altogether to the slag aggregate as described previously.

If the all-slag sections differ from the sections with limestone DGA bases, those differences would be attributable to the slag DGA. Slag is known to have some cementitious qualities and could act somewhat like a weak, cementrated aggregate base or "soil-cement" base (tend to crack at fairly close spacing).

Detailed surveys are needed to resolve the foregoing questions. Sealcoats and overlayments may now obscure the data.

Road Rater deflection tests were made September 26, 1984. Traffic estimates were made 8 years forward, and overlay requirements were determined and reported (by Gary Sharpe, Nov. 30, 1984). Copies of those items are appended and made a part hereof. (Note: EWL´s/32≈ EAL´s)

Meanwhile, double and perhaps triple chip seals have been applied over portions of the road, and full-width overlayment (patching) were being marked for immediate lay-down on other portions farther toward South Shore. The thicknesses of these overlayments would surely exceed one inch and probably equal 1.5 inches in the wheel paths. These overlays, therefore, could approach the thicknesses of overlay required by the analyses of Road Rater data, as reported by Sharpe.

At present, there seems to be both advantages and disadvantages to re-doing Road Rater tests (winter approaching). Design has new estimates of traffic (EWL´s) to extend service life 20 years hence.

Although overlay requirements could be read from Sharpe´s graphs (attached); Sharpe, at this writing, has been requested to submit a proposal for the additional work. His proposal will precede or accompany this report.

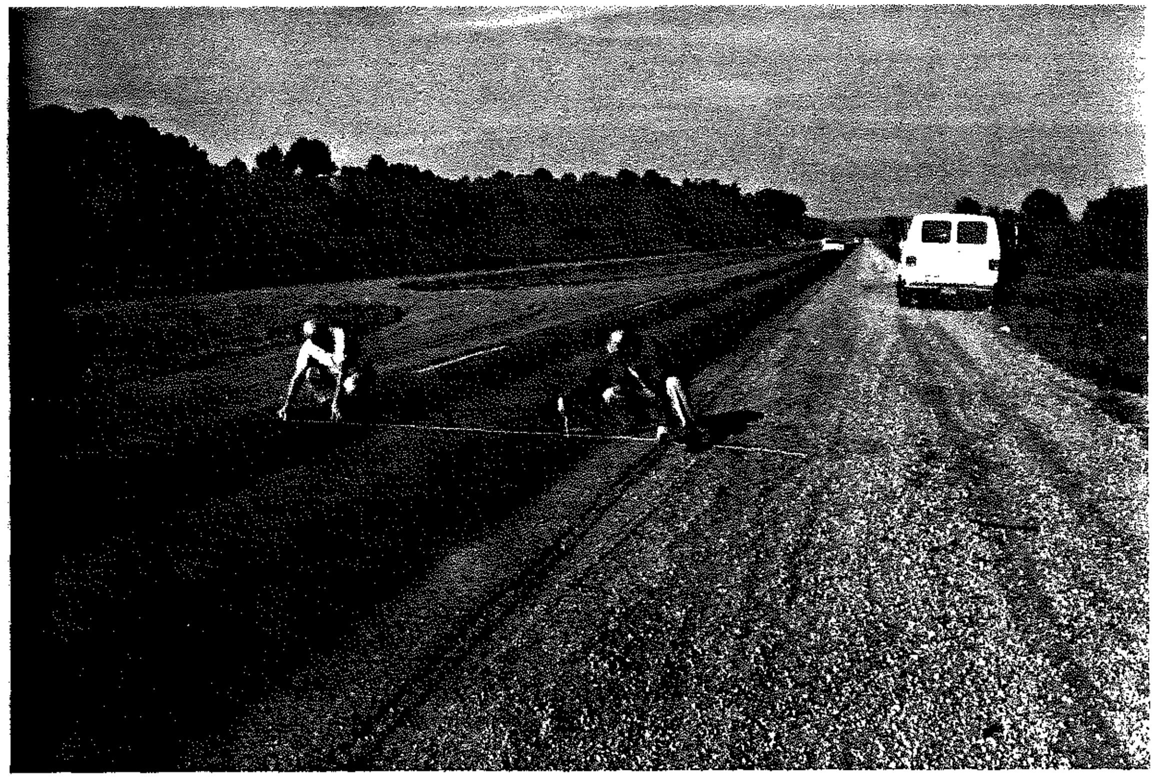
Respectfully submitted,

James H. Havens

James H. Havens, P.E.
Associate Director

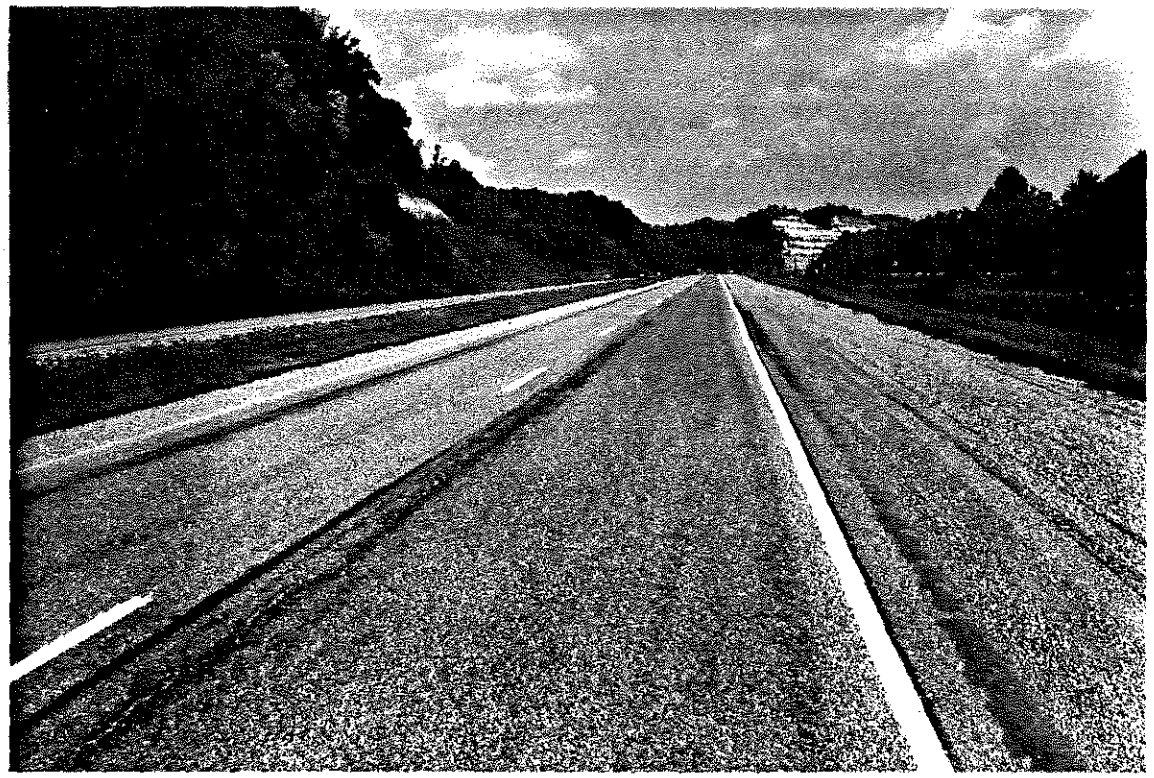
cc: E. B. Drake
A. B. Magee

Attachments



Rutting: Section Chip-Sealed Previously; Depth Nominally 1.5 inches; Inner Lane not Rutted; Facing South Shore (10-10-85)

Cracking: Example of Prominent Crack; Section Chip-Sealed; Not Bleeding (10-10-85)



Section toward South Shore; Chip-Sealed
Aggregate Loss Seems Extensive (10-10-85)

COMMONWEALTH OF KENTUCKY
TRANSPORTATION CABINET
FRANKFORT, KENTUCKY 40622

C. LESLIE DAWSON
SECRETARY
AND
COMMISSIONER OF HIGHWAYS

MARTHA LAYNE COLLINS
GOVERNOR

September 25, 1985

Mr. R. E. Johnson, Division Administrator
Federal Highway Administration
P. O. Box 536
Frankfort, Kentucky 40601

Dear Mr. Johnson:

SUBJECT: Pavement Rehabilitation and Design Team

In May 1984, your office made available assistance of a pavement rehabilitation and design team out of the Washington office, and this team was utilized to a significant advantage on a portion of the Purchase Parkway.

The purpose of this letter is to request assistance from this same team of people on a portion of US 23 in Greenup County between Ashland, Kentucky and Portsmouth, Ohio. This section of road is showing significant distress and various measures have been taken to retard this deterioration. Previous contacts with your office by phone indicate that this team is available and can come to Kentucky on October 21 and 22, 1985. If this is correct, would you please confirm in writing these dates, and we will be gathering preliminary data anticipating this visit.

Thank you for your cooperation in this area in the past. I trust this visit to this project will be fruitful.

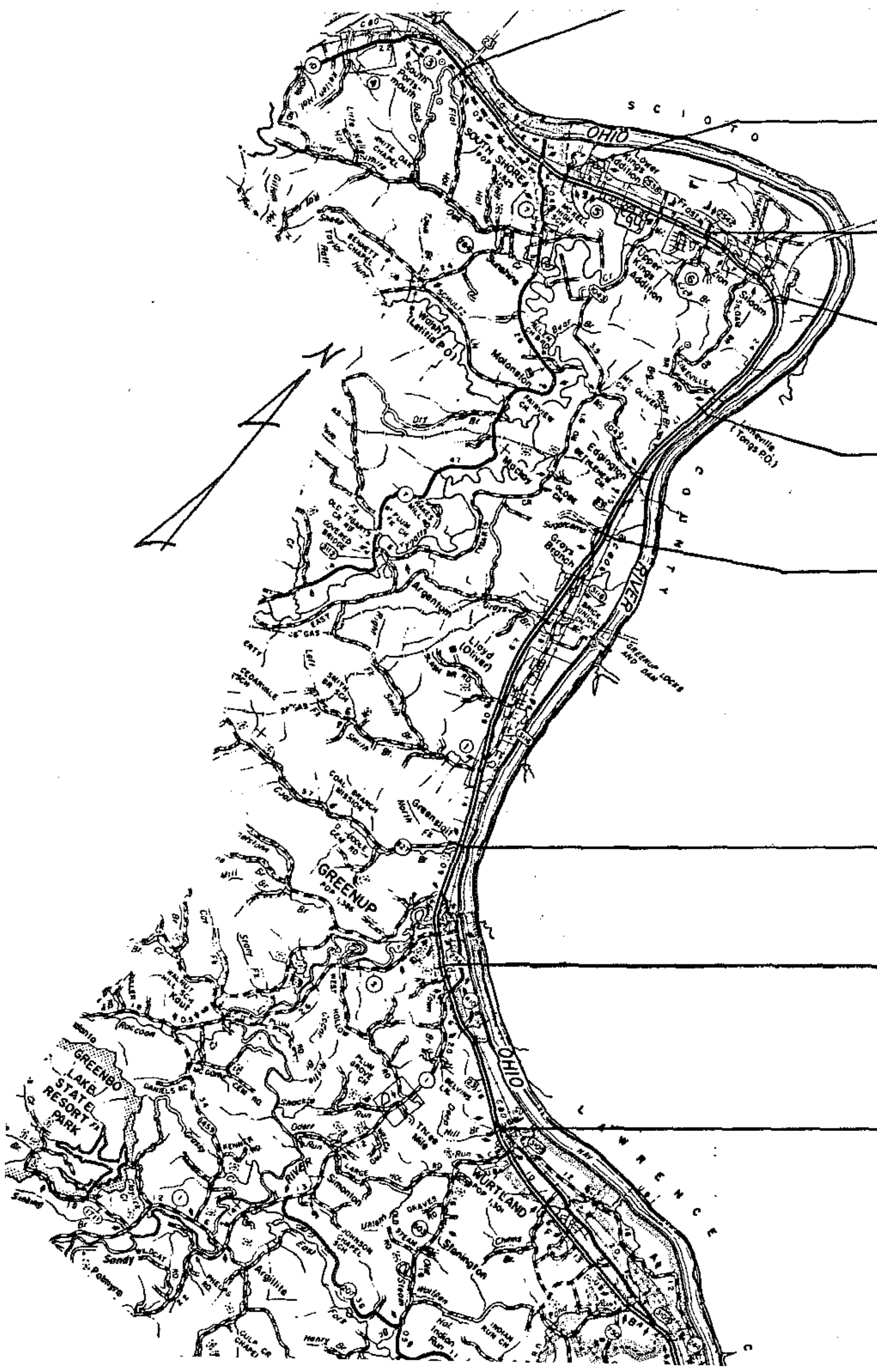
Sincerely,

R. K. Capito, P.E.
State Highway Engineer

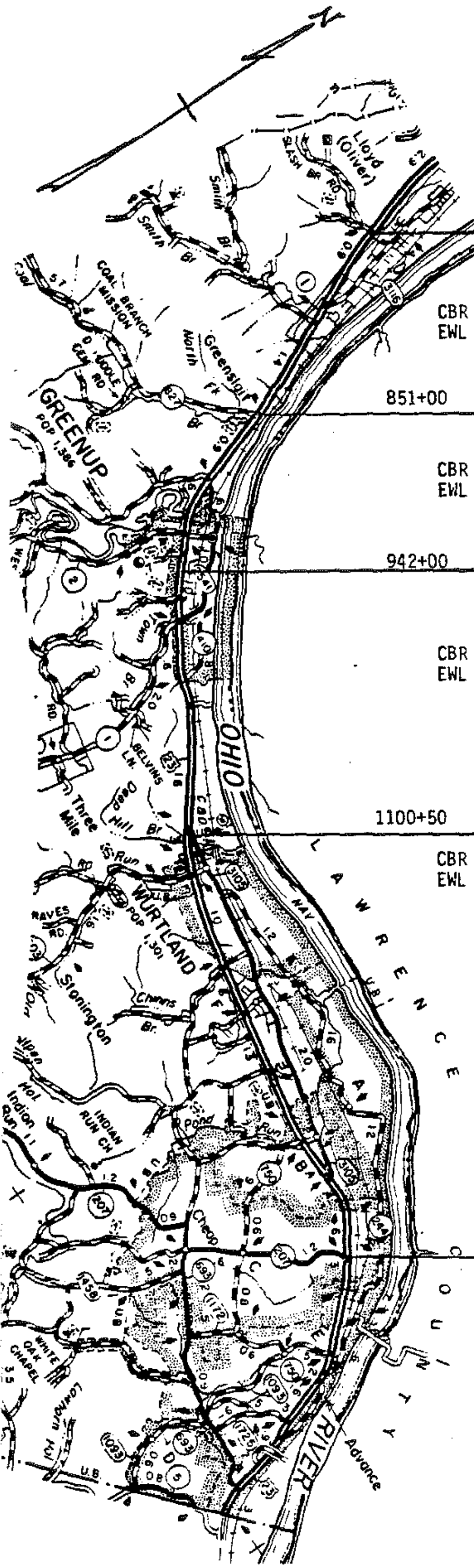
E. B. Archer Fa

By: L. S. Blevins, P. E.
Division of Design

EBD:cjh
cc: C. S. Layson
J. H. Havens
Harrison Evans
John McChord
D. Mullins
J. A. Brown



Project	Station	CBR / EWL	Pavement		
2.017 MILES AWD. 12-2-74 KY. ROAD OILING & EDWARDS & WEBB	206 + 00	EWL = 40-[illegible]	13" DGA 6½" B.S. 5/8" SAS Tp. II Slag Aggr. - DGA, B.B., B.S. - SAS Tp II	FD DGA 3" B.B. 1" B.S.	5" DGA
APD 537(67) 1.712 MILES AWD. 10-30-73 EDWARDS & WEBB	296 + 50	CBR=5 CBR=9 Const. Rev.	12" DGA 6½" B.B. 1" B.S. Ls. Aggr. - DGA Slag Aggr. - B.B., B.S.	FD DGA 3" B.B. 1" B.S.	5" DGA
APD 537(65) 2.718 MILES AWD. 7-26-73 WATTS & CALL CONST.	320 + 00 440 + 00		9½" DGA 5½" B.B. 1" B.S. Ls. Aggr. - DGA Slag Aggr. - B.B., B.S.	— — —	5" DGA
APD 537(55) 2.082 MILES AWD. 8-17-72 KY. ROAD OILING INC. & WATTS & CALL	550 + 00	CBR=9 EWL = 20-40	9½" DGA 5½" B.B. 1" B.S. Ls. Aggr. - DGA, B.B., B.S.	FD DGA 3" B.B. 1" B.S.	5" DGA
APD 537(63) 2.603 MILES AWD. 5-7-73 BIZZACK BROS. CONST. CORP.	687 + 48.76 BK. =580 + 73.93 AH.		9½" DGA 5½" B.B. 1" B.S. Ls. Aggr. - DGA, B.B., B.S.	FD DGA 3" B.B. 1" B.S.	5" DGA
	700 + 00	CBR=5 CBR=9 Const. Rev.	12" DGA 5½" B.B. 1" B.S. Ls. Aggr. - DGA, B.B., B.S.	— — —	5" DGA
APD 537(54) 5.116 MILES AWD. 5-26-72 THE MARBLE CLIFF QUARRIES CO.	851 + 00	CBR=9 EWL = 20-40	9" DGA 5½" B.B. 1" B.S. Lw. Aggr. - DGA, B.B., B.S.	FD DGA 3" B.B. 1" B.S.	5" DGA
APD 537(53) 1.723 MILES AWD. 5-26-72 WATTS & CALL & RR DAWSON BRIDGE	942 + 00		11" DGA 5½" B.B. 1" B.S. Ls. Aggr. - DGA Slag. Aggr. - B.B., B. S.	FD DGA 3" B.B. 1" B.S.	5" DGA
APD 537(52) 3.002 MILES AWD. 7-5-72 KY ROAD OILING	1100 + 50	CBR=6 EWL = 20-40	1085 + 00 G. D. S 1100 + 50 G. D		
APD 537(56) 4.654 MILES AWD. 7-26-73 KY ROAD OILING	1346 + 74.81	CBR=9	11" DGA 5½" B.B. 1" B.S.	FD DGA 3" B.B. 1" B.S.	5" DGA
			9" DGA 5½" B.B. 1" B.S. Slag Aggr. - DGA, B.B., B.S.	FD DGA 3" B.B. 1" B.S.	5" DGA



STA. 728 + 80

A.P.D. 537(54)
Awd. 5-26-72
2.121 Mi. of 5.116 Mi. (Tot.)
MARBLE CLIFF QUARRIES

CBR = 9
EWL = 20-40

9" DGA (LS)
6½" BIT (LS)

851+00

A.P.D. 537(53)
Awd. 5-26-72
1.723 Mi.
WATTS & CALL &
RR DAWSON

CBR = 6
EWL = 20-40

11" DGA (LS)
6½" BIT (Slag)

942+00

A.P.D. 537(52)
Awd. 7-5-72
3.002 Mi.
KY ROAD OILING

CBR = 6
EWL = 20-40

11" DGA (LS)
6½" BIT (Slag)

LS DGA

1100+50

CBR = 6
EWL = 20-40

A.P.D. 537(56)
Awd. 7-26-73
4.654 Mi.
KY ROAD OILING

9" DGA (Slag)
6½" BIT (Slag)

STA. 1346 + 74.81

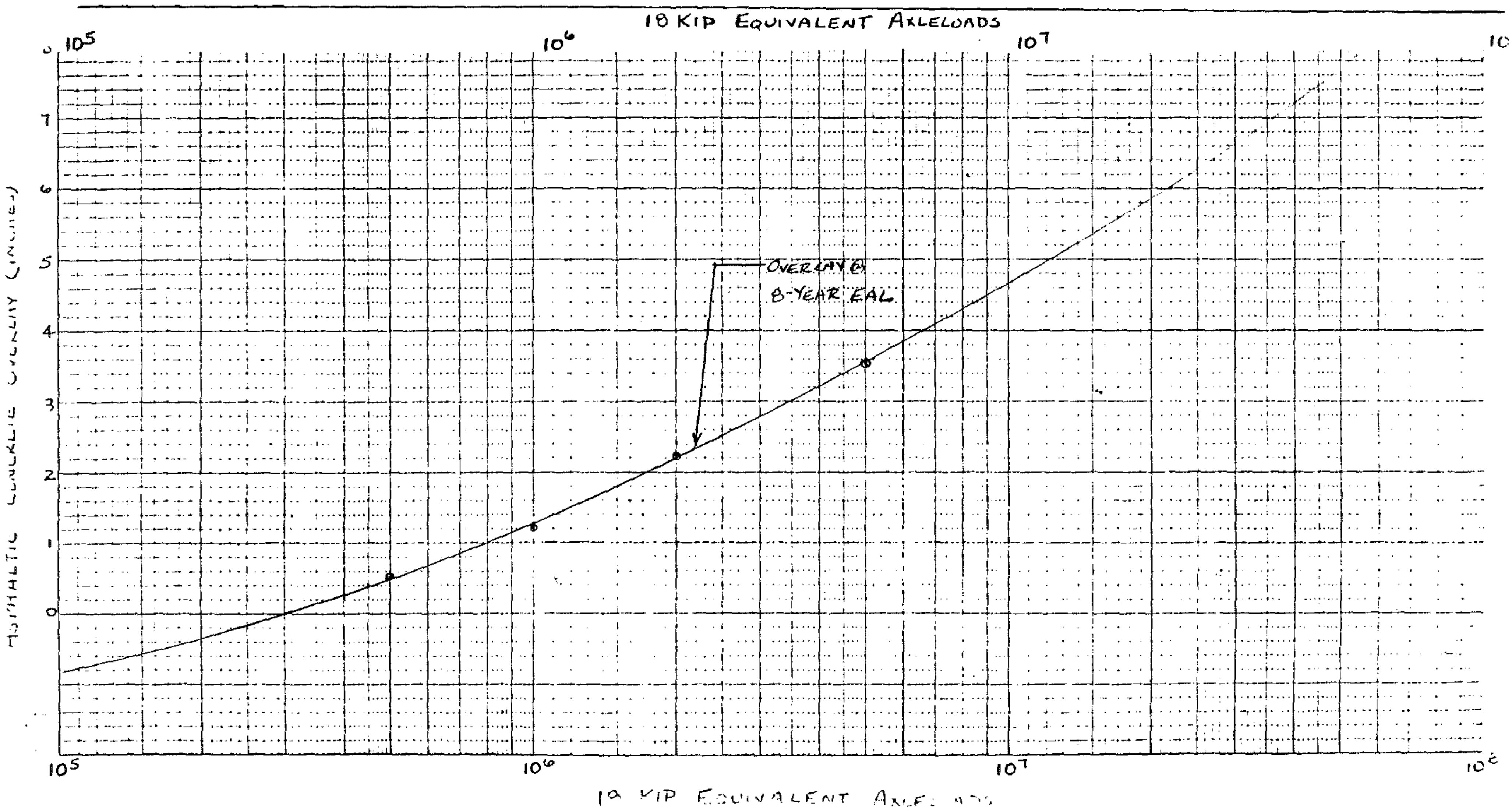
AS
CONSTRUCTED

ROUTE	COUNTY	MILEPOINT FROM	MILEPOINT TO	SYSTEM AID STATE	SYSTEM AID FED	TRAFFIC VOLUME	TRAFFIC YEAR	PAVEMENT TYPE	PAVEMENT YEAR	DATE TESTED	RI BY LANE N/E	RI BY LANE S/W	RI MINUS CRITICAL	COND
US 23	GREENUP	12.60	14.05	SP	FAP	7160	1984	BIT	1973	10-31-84	1.8	1.9	-0.8	POOR
US 23	GREENUP	14.05	15.60	SP	FAP	4739	1982	BIT	1973	10-31-84	1.8	2.3	-0.7	POOR
US 23	GREENUP	15.60	17.52	SP	FAP	4295	1982	BIT	1973	10-31-84	1.4	2.5	-1.0	POOR
US 23	GREENUP	17.52	18.00	SP	FAP	4874	1984	OGFC	1974	10-31-84	2.4	2.4	-0.1	POOR
US 23	GREENUP	18.00	19.01	SP	FAP	4854	1984	OGFC	1974	10-31-84	2.8	3.0	0.3	FAIR
US 23	GREENUP	19.01	20.20	SP	FAP	4742	1984	OGFC	1974	10-31-84	2.4	3.1	-0.1	POOR
US 23	GREENUP	20.20	24.86	SP	FAP	4742	1984	BIT	1975	10-31-84	2.7	3.0	0.2	FAIR
US 23	GREENUP	24.86	25.50	SP	FAP	7806	1984	BIT	1975	10-31-84	2.5	3.1	-0.1	POOR
US 23	GREENUP	25.50	26.44	SP	FAP	9118	1984	BIT	1975	10-31-84	2.8	2.6	-0.1	POOR
US 23	GREENUP	26.44	26.93	SP	FAP	9118	1984	BIT	1976	10-31-84	2.2	2.3	-0.5	POOR
US 23	GREENUP	26.93	27.50	SP	FAP	10497	1983	BIT	1976	10-31-84	3.0	3.4	0.3	FAIR
US 23	GREENUP	27.50	28.40	SP	FAP	10497	1983	BIT	1977	10-31-84	2.9	3.2	0.2	FAIR
US 23	GREENUP	28.40	28.76	SP	FAP	13245	1984	BIT	1977	10-31-84	3.0	2.9	0.2	FAIR
KY 207	GREENUP	9.24	11.00	SS	FAS	783	1983	BIT	1978	9-27-84	2.5	2.8	0.5	FAIR
KY 207	GREENUP	11.00	12.35	SS	FAS	940	1983	BIT	1978	9-27-84	2.8	3.0	0.7	GOOD
KY 207	GREENUP	12.35	12.80	SS	FAS	2003	1983	BIT	1978	9-27-84	2.6	2.4	0.1	FAIR
KY 207	GREENUP	12.80	13.40	SS	FAS	2003	1983	BIT	1978	9-27-84	2.8	2.6	0.3	FAIR
KY 207	GREENUP	13.40	15.25	SS	FAS	2934	1984	BIT	1978	9-27-84	2.8	2.8	0.4	FAIR
KY 207	GREENUP	15.25	15.60	SS	FAU	2934	1984	BIT	1978	9-27-84	3.1	2.9	0.5	FAIR
KY 207	GREENUP	15.60	15.79	SS	FAU	4486	1984	BIT	1978	9-27-84	3.2	3.0	0.5	FAIR
KY 207	GREENUP	15.79	16.10	SS	FAU	7220	1983	BIT	1978	9-27-84	3.4	3.1	0.5	GOOD
KY 207	GREENUP	16.10	16.36	SS	FAU	8640	1983	BIT	1979	9-27-84	3.4	3.0	0.3	FAIR
KY 207	GREENUP	16.36	16.66	SS	FAU	9030	1981	BIT	1979	9-27-84	3.0	3.4	0.3	FAIR
KY 207	GREENUP	16.66	17.28	SS	FAU	8810	1981	BIT	1979	9-27-84	3.5	3.3	0.6	GOOD
KY 207	GREENUP	17.28	17.89	SS	FAU	5730	1984	BIT	1979	9-27-84	2.7	2.8	0.2	FAIR
KY 503	GREENUP	0.00	1.47	SS	FAS	949	1982	BIT	1979	9-27-84	2.5	2.3	0.2	FAIR
KY 503	GREENUP	1.47	3.73	SS	FAS	411	1983	BIT	1979	9-27-84	2.2	2.3	0.5	FAIR
KY 503	GREENUP	3.73	5.48	SS	FAS	1215	1983	BIT	1979	9-27-84	1.6	2.0	-0.6	POOR
KY 503	GREENUP	5.48	7.61	SS	FAS	1169	1983	BIT	1978	9-27-84	2.4	2.7	0.2	FAIR
KY 503	GREENUP	7.61	8.83	SS	FAS	1232	1984	BIT	1978	9-27-84	1.8	2.5	-0.4	POOR
KY 503	GREENUP	8.83	9.29	SS	FAU	1232	1984	BIT	1978	9-27-84	1.6	1.4	-0.8	POOR
KY 693	GREENUP	0.00	0.45	SS	FAU	10859	1984	BIT	1984	9-27-84	3.8	3.6	0.9	GOOD
KY 693	GREENUP	0.45	0.90	SS	FAU	9967	1984	BIT	1984	9-27-84	3.4	3.7	0.7	GOOD
KY 693	GREENUP	0.90	1.53	SS	FAU	11102	1984	BIT	1984	9-27-84	3.4	3.5	0.7	GOOD
KY 693	GREENUP	1.53	2.72	SS	FAU	12614	1984	BIT	1984	9-27-84	3.5	3.6	0.8	GOOD
KY 827	GREENUP	0.00	4.28	SS	FAS	1171	1983	BIT	1980	10-02-84	2.4	2.9	0.2	FAIR
KY 827	GREENUP	4.28	5.65	SS	FAS	1649	1983	BIT	1980	10-02-84	2.2	2.5	-0.1	POOR
KY2538	GREENUP	0.00	0.11	SUPP										
KY2540	GREENUP	0.00	0.94	SUPP	NON			BIT	1977					
KY2541	GREENUP	0.00	0.33	SUPP	NON	3545	1983	BIT	1981					
KY2541	GREENUP	0.33	0.55	SUPP	NON	3475	1978	BIT	1981					
KY2541	GREENUP	0.55	0.96	SUPP	NON	3880	1983	BIT	1981					
KY2541	GREENUP	0.96	1.62	SUPP	NON	675	1983	BIT	1981					
KY2542	GREENUP	0.00	0.15	SUPP	NON			BIT	1975					
KY2543	GREENUP	0.00	0.18	SUPP	FAU	6775	1984	BIT	1975					
KY3117	GREENUP	0.00	0.92	SUPP	NON			BIT	1981					
KY 10	LEWIS	0.00	0.82	SP	FAP	1855	1981	BIT	1978	10-31-84	2.3	2.5	0.0	POOR
KY 10	LEWIS	0.82	3.00	SP	FAP	2980	1984	BIT	1978	10-31-84	2.5	2.7	0.1	FAIR
KY 10	LEWIS	3.00	4.70	SP	FAP	1551	1981	BIT	1983	10-31-84	3.3	3.4	1.0	GOOD
KY 10	LEWIS	4.70	8.20	SP	FAP	1551	1981		1984	10-31-84	3.5	3.4	1.1	GOOD
KY 10	LEWIS	8.20	8.50	SP	FAP	1551	1981		1984	10-31-84	3.9	3.4	1.1	GOOD
KY 10	LEWIS	8.50	9.90	SP	FAP	1724	1981		1984	10-31-84	3.6	3.4	1.1	GOOD
KY 10	LEWIS	9.90	12.36	SP	FAP	1724	1981		1984	10-31-84	3.4	3.5	1.1	GOOD
KY 10	LEWIS	12.36	13.90	SP	FAP	1678	1982		1984	10-31-84	3.5	3.6	1.2	GOOD
KY 10	LEWIS	13.90	14.10	SP	FAP	1678	1982		1984	10-31-84	3.3	2.8	0.5	FAIR
KY 10	LEWIS	14.10	16.70	SP	FAP	1719	1981		1984	10-31-84	3.6	3.8	1.3	GOOD
KY 10	LEWIS	16.70	17.30	SP	FAP	1719	1981		1984	10-31-84	3.5	3.6	1.2	GOOD
KY 10	LEWIS	17.30	19.50	SP	FAP	2187	1984		1984	10-31-84	3.6	3.5	1.2	GOOD
KY 10	LEWIS	19.50	19.91	SP	FAP	5506	1982		1984	10-31-84	3.2	3.1	0.6	GOOD
KY 10	LEWIS	19.91	20.18	SP	FAP	3734	1982	BIT	1960	10-31-84	2.0	2.2	-0.4	POOR
KY 10	LEWIS	20.18	20.35	SP	FAP	4272	1982	BIT	1960	10-31-84	1.4	2.3	-1.0	POOR
KY 10	LEWIS	20.35	20.60	SP	FAP	3613	1982	BIT	1960	10-31-84	1.6	2.0	-0.8	POOR
KY 10	LEWIS	20.60	22.44	SP	FAP	3029	1982	BIT	1967	10-31-84	1.7	2.1	-0.7	POOR
KY 10	LEWIS	22.44	24.19	SP	FAP	3056	1983	BIT	1967	10-31-84	2.3	2.7	-0.1	POOR
KY 10	LEWIS	24.19	29.02	SP	FAP	2236	1981	BIT	1967	10-31-84	1.9	2.1	-0.4	POOR
KY 10	LEWIS	29.02	29.50	SP	FAP	3442	1982	BIT	1967	10-31-84	2.4	3.0	0.0	POOR
KY 10	LEWIS	29.50	31.82	SP	FAP	3442	1982	BIT	1982	10-31-84	3.6	3.5	1.1	GOOD
KY 10	LEWIS	31.82	35.85	SP	FAP	2221	1981	BIT	1982	10-31-84	3.4	3.3	1.0	GOOD
KY 10	LEWIS	35.85	39.21	SP	FAP	2165	1981	BIT	1982	10-31-84	3.3	3.1	0.8	GOOD
KY 57	LEWIS	0.00	1.41	SS	FAS	855	1981	BIT	1975					

ROUTE	COUNTY	MILEPOINT FROM	MILEPOINT TO	SYSTEM AID STATE	SYSTEM AID FED	TRAFFIC VOLUME	TRAFFIC YEAR	PAVEMENT TYPE	PAVEMENT YEAR	DATE TESTED	RI BY LANE N/E	RI BY LANE S/W	RI MINUS CRITICAL	COND	
KY 888	FLEMING	0.00	1.27	SUPP	NON	85	1984	CHIPSEAL	1979						
KY1013	FLEMING	0.00	2.18	SUPP	NON	149	1984								
KY1013	FLEMING	2.18	4.84	SUPP	NON	140	1984								
KY1013	FLEMING	4.84	6.26	SUPP	NON	149	1984								
KY1123	FLEMING	0.00	1.60	SUPP	NON	82	1984	BIT	1983						
KY1123	FLEMING	1.60	2.45	SUPP	NON	135	1984	BIT	1983						
KY1200	FLEMING	0.00	2.26	SUPP	NON	231	1984	CHIPSEAL	1980						
KY1200	FLEMING	2.26	4.34	SUPP	NON	111	1983	CHIPSEAL	1980						
KY1336	FLEMING	0.00	1.81	SUPP	NON	68	1984	CHIPSEAL	1981	9-14-83		0.1	-1.3	POOR	
KY1515	FLEMING	0.00	1.31	SUPP	NON	193	1984	BIT	1980						
KY1515	FLEMING	1.31	2.68	SUPP	NON	77	1984	BIT	1980						
KY1515	FLEMING	2.68	4.94	SUPP	NON	48	1984	BIT	1980						
KY1895	FLEMING	0.00	1.46	SUPP	NON	164	1984								
KY1895	FLEMING	1.46	2.90	SUPP	NON	332	1984								
KY1902	FLEMING	0.00	0.86	SUPP	NON	139	1984	BIT	1980						
KY1902	FLEMING	0.86	2.49	SUPP	NON	372	1984	BIT	1980						
KY2503	FLEMING	0.00	0.14	SUPP	NON	2420	1984								
KY2504	FLEMING	0.00	0.22	SUPP	NON	2226	1984								
KY2504	FLEMING	0.22	0.42	SUPP	NON	2226	1984								
KY2504	FLEMING	0.42	0.60	SUPP	NON	606	1984								
KY2505	FLEMING	0.00	0.74	SUPP	NON	135	1984								
KY2506	FLEMING	0.00	0.08	SUPP											
KY2507	FLEMING	0.00	0.15	SUPP	NON										
KY2508	FLEMING	0.00	0.10	SUPP											
KY2510	FLEMING	0.00	0.50	SUPP	NON										
KY 1	GREENUP	0.00	1.20	SP	FAS	1057	1983	BIT	1983	11-09-84	3.5	3.5	1.4	GOOD	
KY 1	GREENUP	1.20	4.00	SP	FAS	961	1983	BIT	1983	11-09-84	3.5	3.5	1.4	GOOD	
KY 1	GREENUP	4.00	9.30	SP	FAS	961	1983	BIT	1972	11-09-84	2.8	2.5	0.4	FAIR	R85
KY 1	GREENUP	9.30	9.59	SP	FAS	961	1983	BIT	1976	11-09-84	2.1	2.0	-0.1	POOR	R85
KY 1	GREENUP	9.59	10.93	SP	FAS	1464	1983	BIT	1976	11-09-84	2.4	2.4	0.2	FAIR	R85
KY 1	GREENUP	10.93	11.44	SP	FAS	1464	1983	BIT	1976	11-09-84	3.1	2.9	0.7	GOOD	
KY 1	GREENUP	11.44	12.85	SP	FAS	2018	1983	BIT	1976	11-09-84	3.0	3.1	0.7	GOOD	
KY 1	GREENUP	12.85	14.68	SP	FAS	1782	1983	BIT	1981	11-09-84	3.2	3.0	0.7	GOOD	
KY 1	GREENUP	14.68	16.51	SP	FAS	2455	1983	BIT	1981	11-09-84	3.3	3.1	0.8	GOOD	
KY 1	GREENUP	16.51	17.19	SP	FAS	2984	1983	BIT	1981	11-09-84	3.3	3.6	0.9	GOOD	
KY 1	GREENUP	17.19	17.34	SP	FAS			BIT	1981	11-09-84	3.0	2.9			
KY 2	GREENUP	0.00	1.88	SS	FAS	798	1983	BIT	1982	10-02-84	3.6	3.6	1.6	GOOD	
KY 2	GREENUP	1.88	4.71	SS	FAS	874	1983	BIT	1982	10-02-84	3.4	3.5	1.4	GOOD	
KY 2	GREENUP	4.71	6.20	SS	FAS	956	1983	BIT	1982	10-02-84	3.4	3.4	1.3	GOOD	
KY 2	GREENUP	6.20	7.87	SS	FAS	508	1983	BIT	1977	10-02-84	2.4	2.8	0.6	FAIR	
KY 2	GREENUP	7.87	10.31	SS	FAS	712	1983	BIT	1977	10-02-84	2.5	2.8	0.5	FAIR	
KY 2	GREENUP	10.31	15.45	SS	FAS	1037	1983	BIT	1977	10-02-84	2.3	2.5	0.2	FAIR	
KY 2	GREENUP	15.45	16.84	SS	FAS	1625	1983	BIT	1977	10-02-84	1.9	2.0	-0.4	POOR	
KY 2	GREENUP	16.84	17.19	SS	FAS	2175	1983	BIT	1977	10-02-84	2.9	2.8	0.5	FAIR	
KY 5	GREENUP	0.00	0.79	SS	FAU	5125	1984		1983						
KY 7	GREENUP	0.00	1.24	SS	FAS	698	1983	OGFC	1974	10-02-84	3.4	3.5	1.5	GOOD	
KY 7	GREENUP	1.24	5.70	SS	FAS	979	1984	OGFC	1974	10-02-84	3.3	3.5	1.2	GOOD	
KY 7	GREENUP	5.70	7.27	SS	FAS	979	1984	BIT	1977	10-02-84	2.6	3.0	0.5	FAIR	
KY 7	GREENUP	7.27	8.65	SS	FAS	894	1983	BIT	1977	10-02-84	2.9	2.9	0.9	GOOD	
KY 7	GREENUP	8.65	12.95	SS	FAS	679	1983	BIT	1977	10-02-84	2.8	3.0	0.9	GOOD	
KY 7	GREENUP	12.95	16.66	SS	FAS	1198	1983	OGFC	1975	10-02-84	2.3	2.4	0.1	FAIR	R85
KY 7	GREENUP	16.66	18.76	SS	FAS	1875	1983	OGFC	1975	10-02-84	1.9	1.8	-0.5	POOR	R85
KY 7	GREENUP	18.76	19.98	SS	FAS	5056	1983	OGFC	1975	10-02-84	2.1	1.8	-0.7	POOR	R85
KY 7	GREENUP	19.98	20.28	SUPP	FAS	5056	1983								
KY 10	GREENUP	0.00	3.04	SP	FAP	4975	1983	BIT	1977	10-31-84	2.6	2.6	0.1	FAIR	
US 23	GREENUP	0.00	0.30	SP	FAP	30827	1984	BIT	1968	10-31-84	3.7	4.0	1.0	GOOD	
US 23	GREENUP	0.30	0.50	SP	FAP	20488	1984	BIT	1968	10-31-84	3.7	4.0	1.0	GOOD	
US 23	GREENUP	0.50	0.90	SP	FAP	20488	1984	BIT	1963	10-31-84	3.5	3.7	0.8	GOOD	
US 23	GREENUP	0.90	1.22	SP	FAP	20488	1984	BIT	1970	10-31-84	3.7	3.7	1.0	GOOD	
US 23	GREENUP	1.22	1.84	SP	FAP	20525	1984	BIT	1970	10-31-84	3.6	3.8	0.9	GOOD	
US 23	GREENUP	1.84	2.00	SP	FAP	18091	1984	BIT	1970	10-31-84	0.7	1.8	-2.0	POOR	
US 23	GREENUP	2.00	3.08	SP	FAP	18091	1984	BIT/PCC	1979	10-31-84	2.7	2.6	-0.1	POOR	
US 23	GREENUP	3.08	3.20	SP	FAP	12610	1984	BIT/PCC	1979	10-31-84	2.5	2.0	-0.7	POOR	
US 23	GREENUP	3.20	4.10	SP	FAP	12610	1984	BIT	1976	10-31-84	2.7	1.7	-1.0	POOR	
US 23	GREENUP	4.10	4.51	SP	FAP	11322	1984	BIT	1976	10-31-84	1.8	2.8	-0.9	POOR	
US 23	GREENUP	4.51	7.58	SP	FAP	12360	1981	BIT	1976	10-31-84	2.5	2.4	-0.3	POOR	
US 23	GREENUP	7.58	8.06	SP	FAP	10864	1984	BIT	1975	10-31-84	1.7	2.1	-1.0	POOR	
US 23	GREENUP	8.06	10.25	SP	FAP	12778	1983	BIT	1975	10-31-84	2.0	2.5	-0.7	POOR	
US 23	GREENUP	10.25	11.18	SP	FAP	12365	1984	BIT	1975	10-31-84	3.1	2.0	-0.7	POOR	
US 23	GREENUP	11.18	12.60	SP	FAP	8896	1984	BIT	1973	10-31-84	2.5	2.1	-0.6	POOR	

ION	TEST DATE	EXISTING LAYER THICKNESSES (INCHES) AC	DGA	8-YEAR EAL's	OVERLAY THICKNESS RECOMMENDATOPMS (INCHES)
est	9-26-84	5.50	8.00	680,000	2.41
	5-3-84	5.50	8.00	548,000	2.25*
	9-26-84	6.50	12.00	2,300,000	2.35
	9-26-84	6.50	12.00	2,300,000	2.68
	9-26-84	6.50	12.00	2,200,000	1.79
	9-26-84	6.50	12.00	2,200,000	2.15
	9-26-84	6.50	12.00	1,400,000	0.39
	9-26-84	6.50	12.00	1,400,000	1.45
	9-26-84	6.50	12.00	1,300,000	1.76
	9-26-84	6.50	12.00	1,300,000	1.84

COUNTY	GREENUP	CRUSHED STONE	12.00
MILEPOINTS		DATE OF DEFLECTION EVALUATION	9-26-84
BEGIN	3.08		
END	9.63	EIGHT YEAR EAL'S	2.3×10^6
DIRECTION	NORTH		



COUNTY GREENUP

CRUSHED STONE 12.00

MILEPOINTS

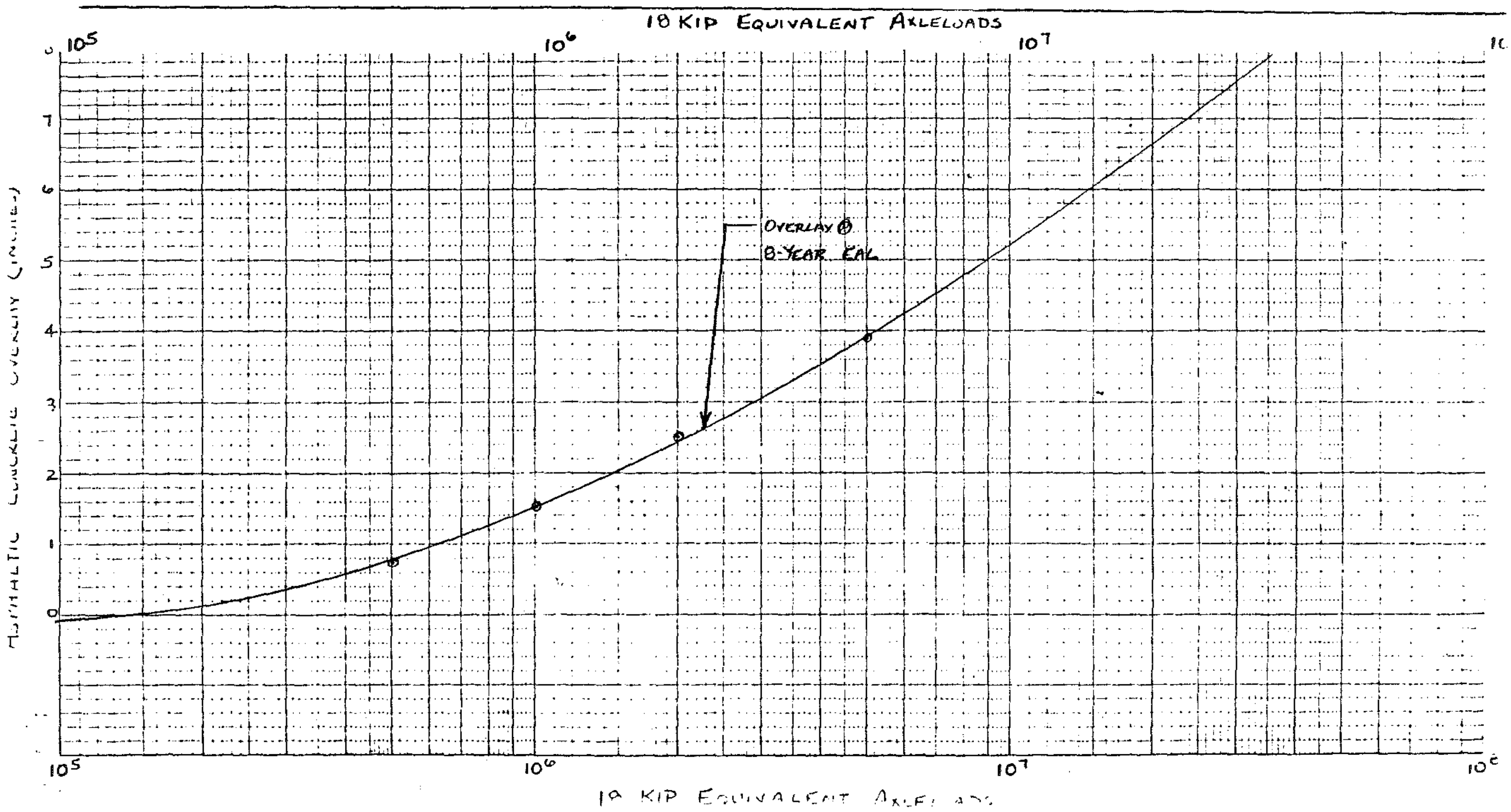
BEGIN 3.08

END 9.63

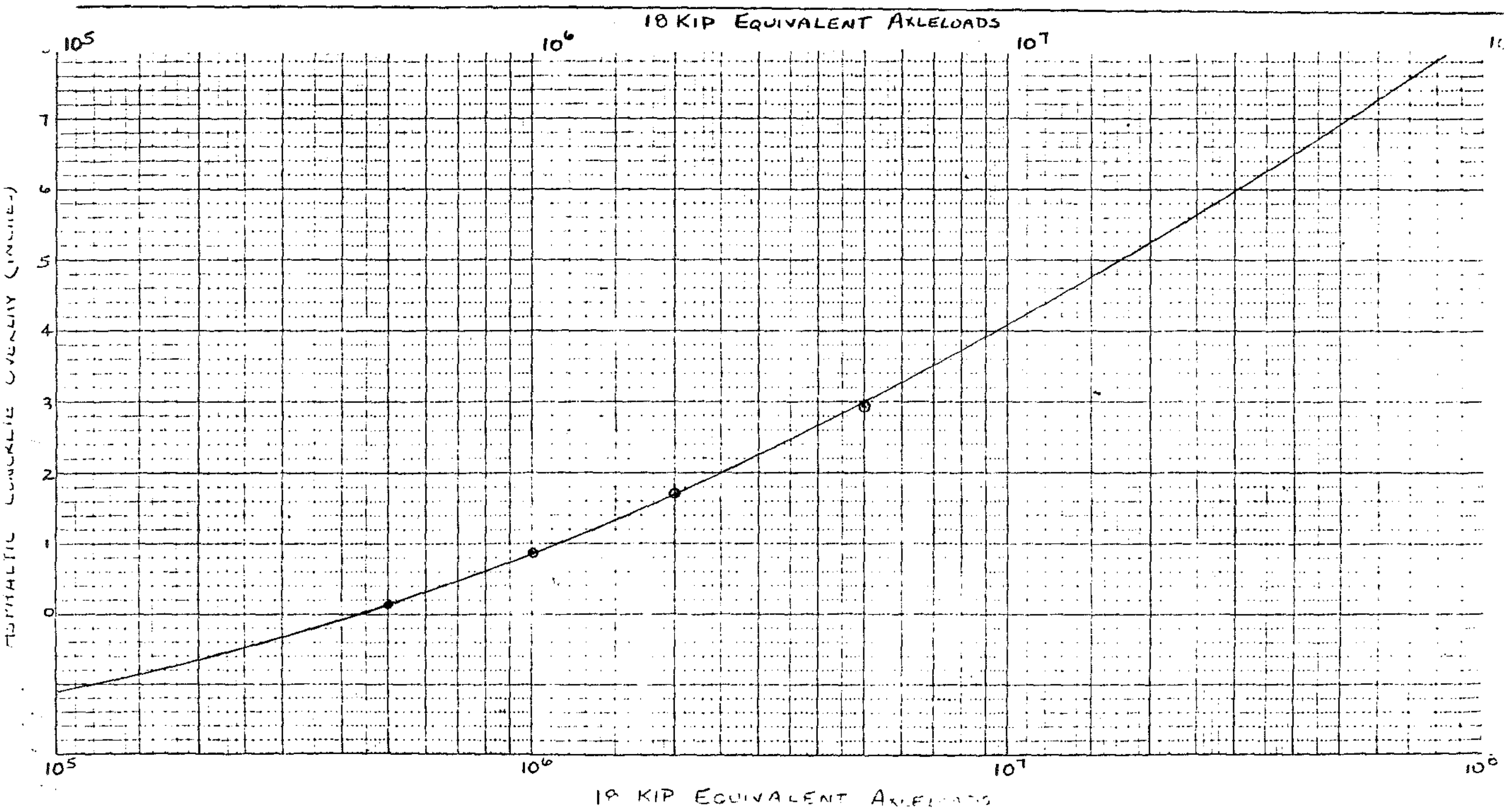
DATE OF DEFLECTION EVALUATION 9-26-84

EIGHT YEAR EAL'S 2.3×10^6

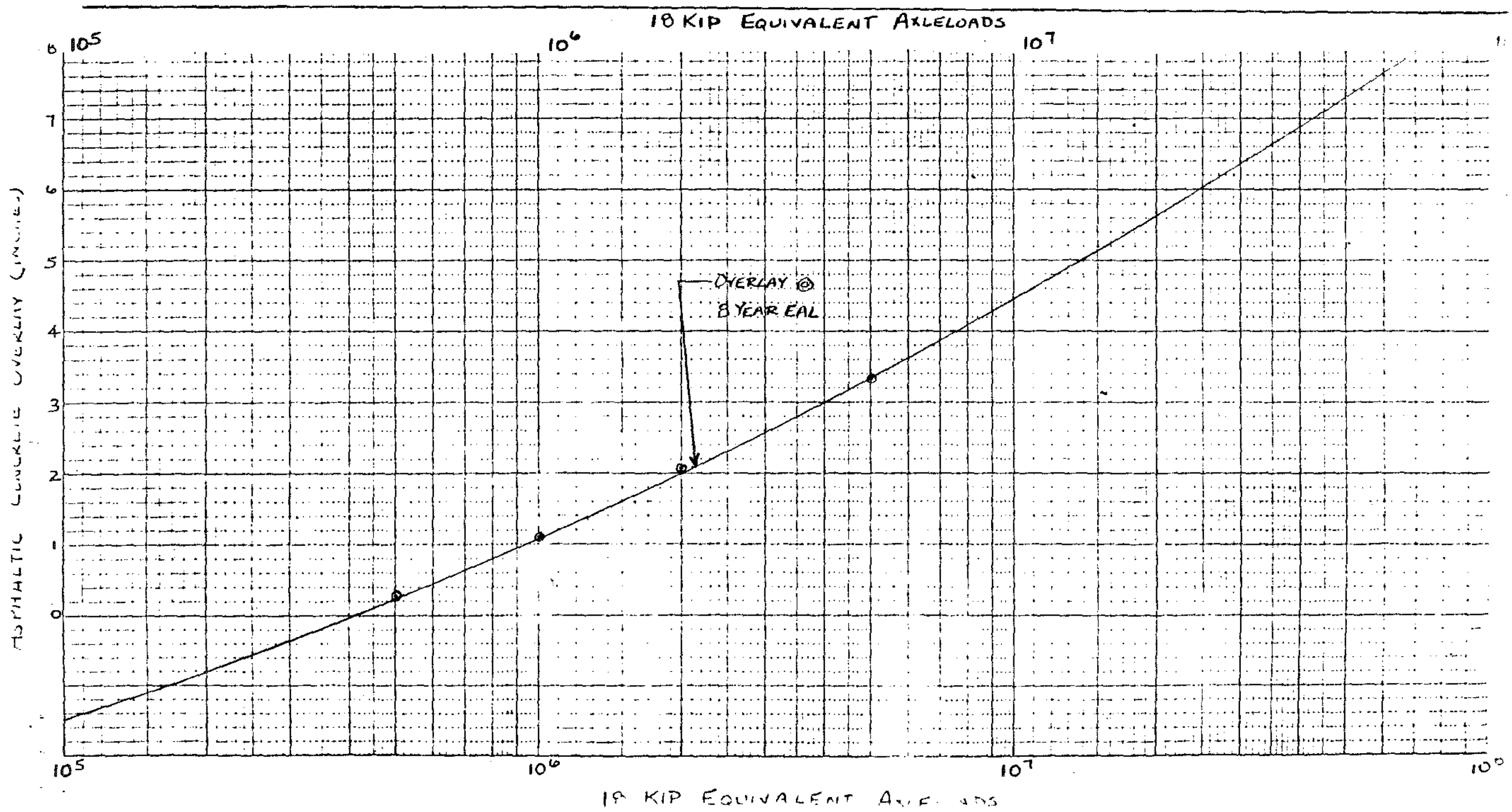
DIRECTION SOUTH



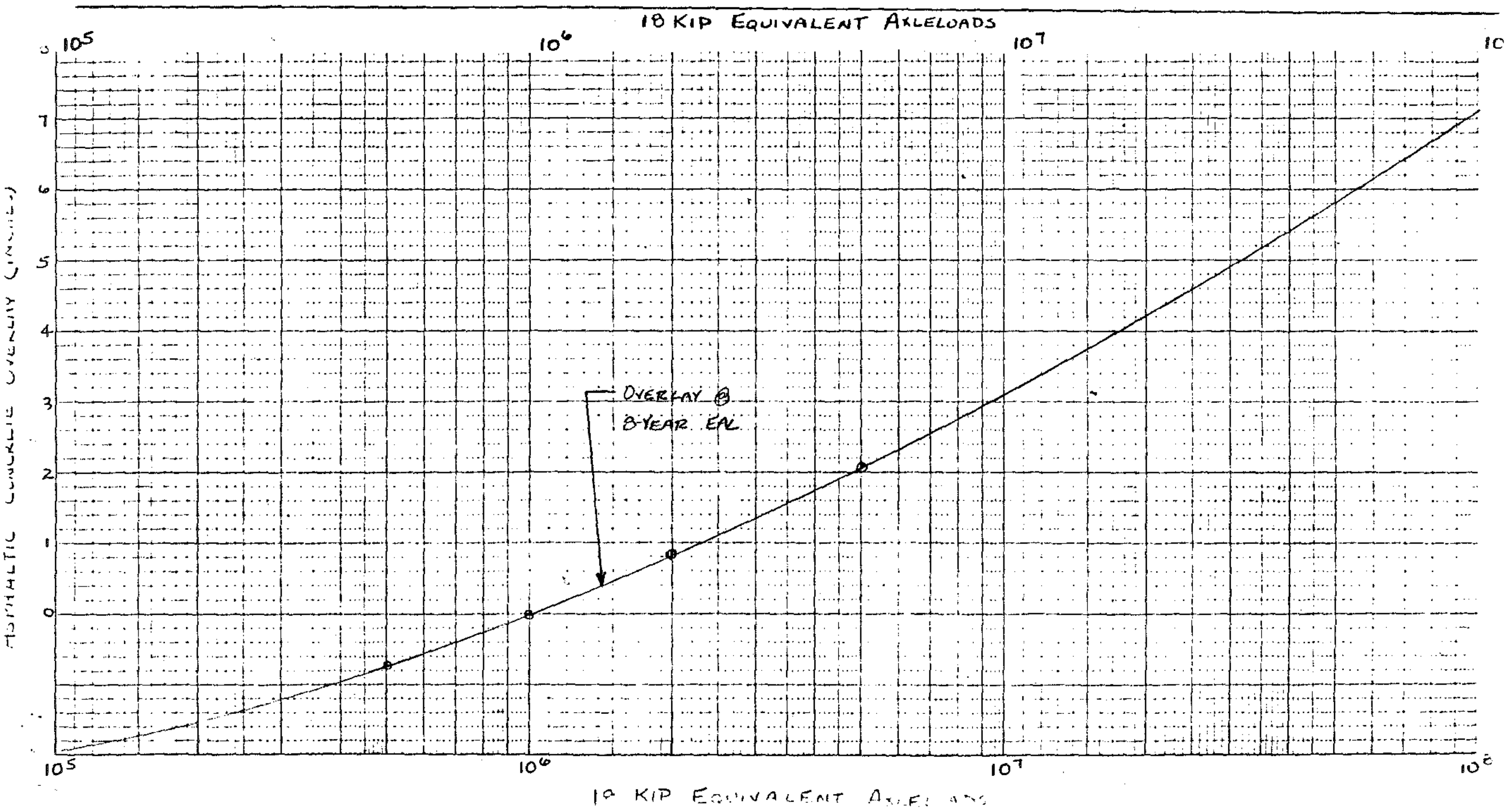
COUNTY	GREENUP	ASPHALTIC CONCRETE	6.00
		CRUSHED STONE	12.00
MILEPOINTS		DATE OF DEFLECTION EVALUATION	9-26-84
BEGIN	9.63		
END	12.61	EIGHT YEAR EAL'S	2.2×10^6
DIRECTION	NORTH		



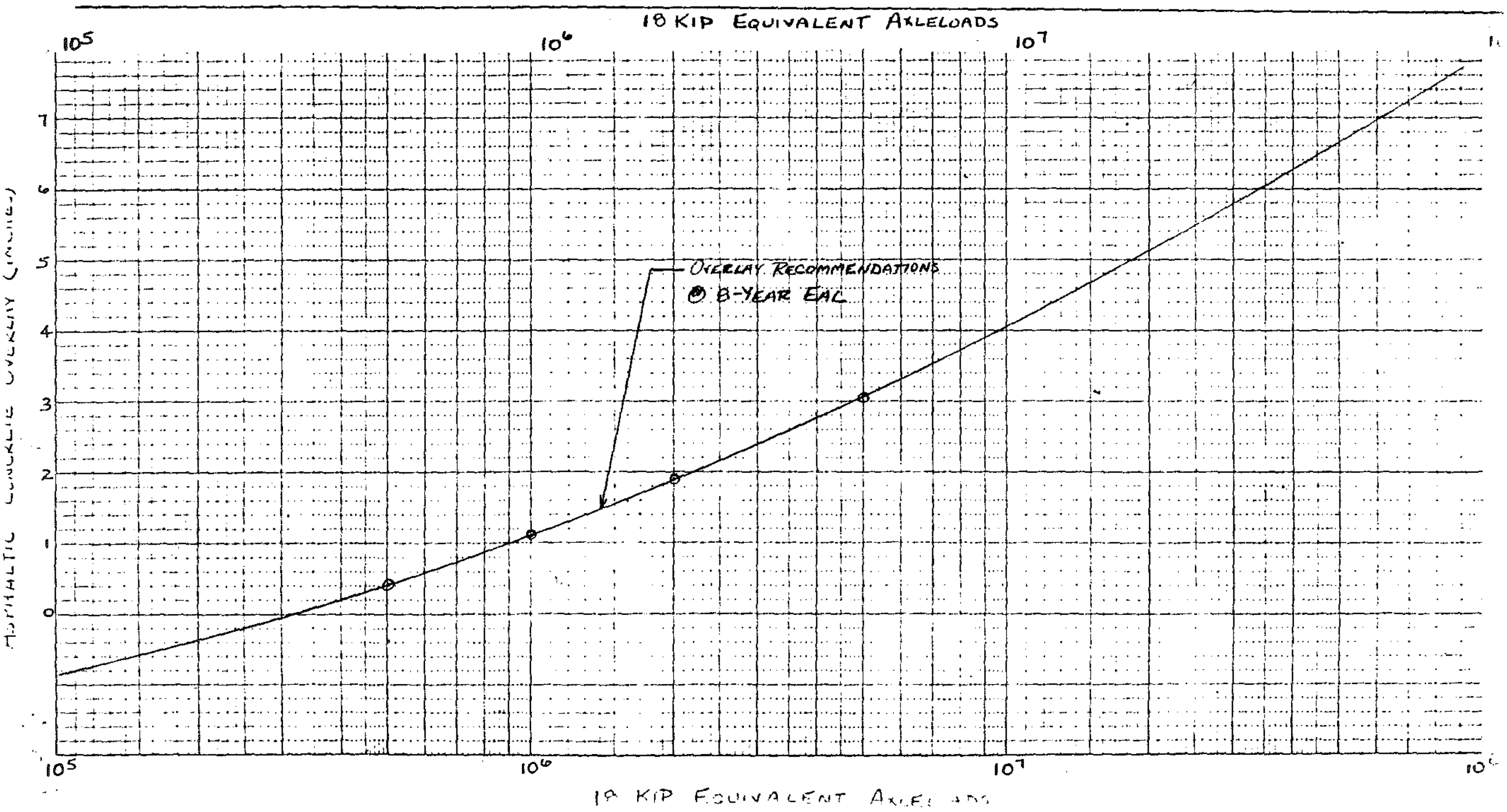
COUNTY	GREENUP	ASPHALTIC CONCRETE	6.50
		CRUSHED STONE	12.00
MILEPOINTS		DATE OF DEFLECTION EVALUATION	9-26-84
BEGIN	9.63		
END	12.61	EIGHT YEAR EAL'S	2.2×10^6
DIRECTION	SOUTH		



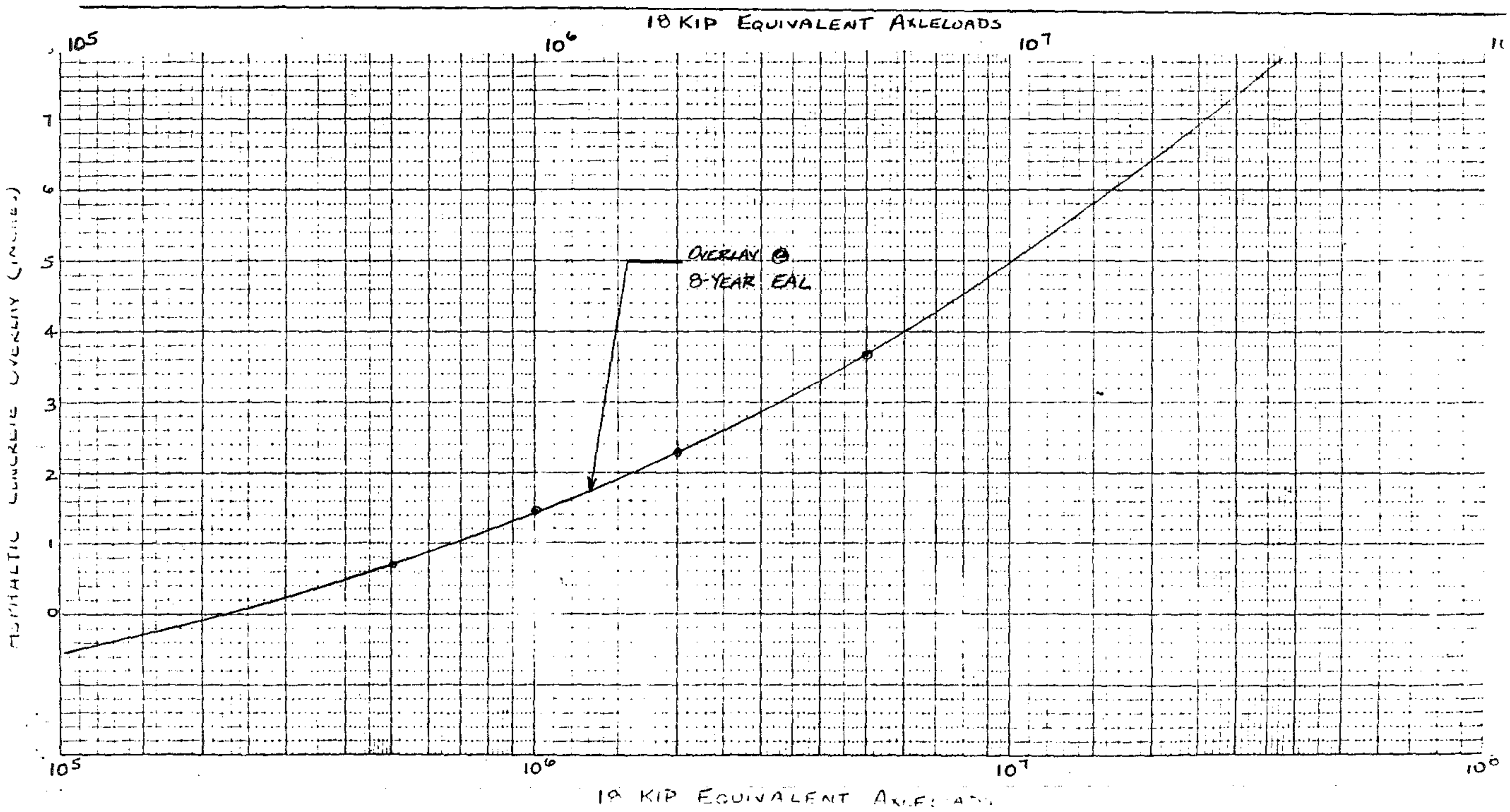
COUNTY	GREENUP	ASPHALTIC CONCRETE	6.50
		CRUSHED STONE	12.00
MILEPOINTS		DATE OF DEFLECTION EVALUATION	9-26-84
BEGIN	12.61		
END	17.52	EIGHT YEAR EAL'S	1.40×10^6
DIRECTION	NORTH		



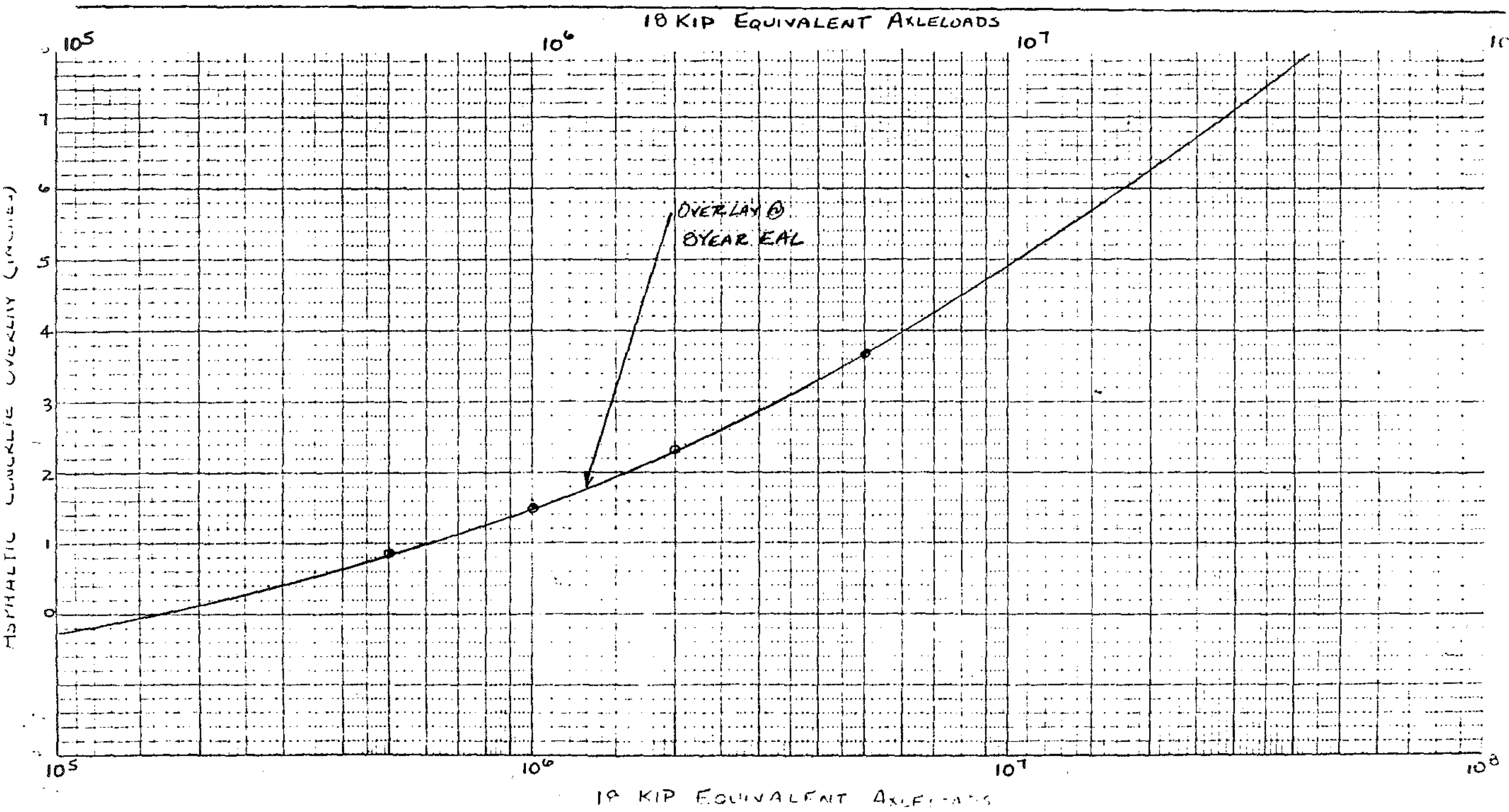
COUNTY	GREENUP	ASPHALTIC CONCRETE	6.50
		CRUSHED STONE	12.00
MILEPOINTS		DATE OF DEFLECTION EVALUATION	9-26-84
BEGIN	12.61		
END	17.52	EIGHT YEAR EAL'S	1.40×10^6
DIRECTION	SOUTH		



COUNTY	GREENUP	ASPHALTIC CONCRETE	6.50
		CRUSHED STONE	12.00
MILEPOINTS		DATE OF DEFLECTION EVALUATION	9-26-84
BEGIN	17.52		
END	20.24	EIGHT YEAR EAL'S	1.3×10^6
DIRECTION	NORTH		



COUNTY	GREENUP	ASPHALTIC CONCRETE	6.50
		CRUSHED STONE	12.00
MILEPOINTS		DATE OF DEFLECTION EVALUATION	9-26-84
BEGIN	17.52		
END	20.52	EIGHT YEAR EAL'S	1.3×10^6
DIRECTION	SOUTH		



H.5.23

OYD G. POORE
SECRETARY

COMMONWEALTH OF KENTUCKY
TRANSPORTATION CABINET
FRANKFORT, KENTUCKY 40622

MARTHA LAYNE COLLINS
GOVERNOR

October 29, 1984

Dr. Robert C. Deen, Director
Kentucky Transportation Research Program
College of Engineering
University of Kentucky
533 South Limestone Street
Lexington, KY 40506-0043

Subject: Greenup County - US 23
From MP 3.076 to 20.2
Nicholas County - US 68
From MP 10.42 to Robertson Co. Line (MP 12.211)

Dear Bob:

In August 1984, you were requested to perform structural evaluation of the subject AC pavements. The applicable EAL estimates for the 8-year load life are summarized on the attached tabulations. The calculation sheets are also attached.

If you have any questions, please let me know.

Sincerely,

JSDeale

for R. L. Rizenbergs, P.E.
Associate Assistant State Highway
Engineer for Pavement Management
State Highway Engineer's Office

RLR:JSD:kss

Attachments

c: A. R. Romine
Cy Layson
Bennie Wheat

RECEIVED
OCT 31 1984
KENTUCKY TRANSPORTATION
RESEARCH

)

TRAFFIC VOLUME GROUP 3000 +

GREENUP ROAD NAME Ashland - So. Portsmouth ROUTE NO. US23

'T LIMITS From KY207, MP 3.076 in Flatwoods to MP 9.629 near ECL of Greenup PROJECT NO. ______

ETER STATION REFERENCE Special Weight Data - Greenup Co. Sta. 004 (76)

'er Cent of Trucks 7

verage Axles per Truck 3.595

verage 24 Hour Traffic . . . . 1988 ADT = ... 13,900

verage 24 Hour Truck Traffic=(1) x (3) . . . . ______

verage 24 Hour Truck Traffic at End of 8 Year Period=. (1) x (3) . . 970

verage Axles per Truck at End of 8 Year Period = (2) + 0.08 . . . . 3.675

'otal Axles in 8 Years = (5) x (6) x 365 x 8 10,409,070

	(B) Total Axles (7)	(C) % of Total Axles From Load Sta.	(D) Correction	(E) Corrected % of Total Axles (C) + (D)	(F) Total Axles by Weight Class (B) x (E)	(G) EWL Factor	(H) EWL for Two Direction: (F) x (G)
	10,409,070	15.125	0.04	15.165	1,578,535	1	1,578,535
	"	7.659	0.05	7.709	802,435	2	1,604,870
	"	8.333	0.11	8.443	878,838	4	3,515,352
	"	8.719	0.06	8.779	913,812	8	7,310,496
	"	4.817	0.04	4.857	505,569	16	8,089,104
	"	2.842	0.02	2.862	297,908	32	9,533,056
½	"	2.264	0	2.264	235,661	64	15,082,304
½	"	1.927	0	1.927	200,583	128	25,674,624
					TOTAL EWL for 8 year period (two directions)		72,388,341

$$\frac{72,388,341}{20} \times 0.497 - (1.84 + 1.42 \times 0.07) \times 10^{-6} \times 13,900$$

2.3×10^{6} EAL's

$3,619,417 \times 0.497 - (1.939 \times 0.000001 \times 13,900)$

$3,619,417 \times 0.470 = 1,701,126$ EALs/Lane (4Lane-2Way)

10-23-84

[signature]

'OTE: THIS ESTIMATE DOES NOT ASSUME THE PROPOSED BRIDGE ACROSS THE GREENUP DAM OR THE PROPOSED AA HWY.

TRAFFIC VOLUME GROUP 3000 ≠

: GREENUP ROAD NAME ASHLAND - SO. PORTSMOUTH ROUTE NO. US23

CT LIMITS FROM MP 9.629 NEAR ECL OF GREENUP TO KY 807, MP 12.605 PROJECT NO. ______

IETER STATION REFERENCE SPECIAL WEIGHT DATA - GREENUP CO. STA 004 (76)

Per Cent of Trucks 8

Average Axles per Truck 3.595

Average 24 Hour Traffic . . . . 1988 ADT 11,700

Average 24 Hour Truck Traffic=(1) x (3) . . . . ______

Average 24 Hour Truck Traffic at End of 8 Year Period= (1) x (3) . . 940

Average Axles per Truck at End of 8 Year Period = (2) ≠ 0.08 . . . . 3.675

Total Axles in 8 Years = (5) x (6) x 365 x 8 10,087,140

	(B) Total Axles (7)	(C) % of Total Axles From Load Sta.	(D) Correction	(E) Corrected % of Total Axles (C) ≠ (D)	(F) Total Axles by Weight Class (B) x (E)	(G) EWL Factor	(H) EWL for Two Direction (F) x (G)
	10,087,140	15.125	0.04	15.165	1,529,715	1	1,529,715
	"	7.659	0.05	7.709	777,618	2	1,555,236
	"	8.333	0.11	8.443	851,657	4	3,406,628
	"	8.719	0.06	8.779	885,550	8	7,084,400
	"	4.817	0.04	4.857	489,932	16	7,838,912
	"	2.842	0.02	2.862	288,694	32	9,238,208
½	"	2.264	0	2.264	228,373	64	14,615,872
½	"	1.927	0	1.927	194,379	128	24,880,512
						TOTAL EWL for 8 year period (two directions)	70,149,483

$\frac{70,149,483}{20} \times 0.497 - (1.84 + 1.42 \times 0.08) \times 10^{-6} \times 11,700$

$3,507,474 \times 0.497 - (1.954 \times 0.000001 \times 11,700)$

$3,507,474 \times 0.474 = 1,662,543$ EALs/LANE (4LANE-2WAY)

2.2×10^6 EAL's

10-23-84

NOTE: THIS ESTIMATE DOES NOT ASSUME THE PROPOSED BRIDGE ACROSS THE GREENUP DAM OR THE PROPOSED AA HWY.

TRAFFIC VOLUME GROUP 3000 +

GREENUP ROAD NAME ASHLAND - SO. PORTSMOUTH ROUTE NO. US23

T LIMITS FROM KY807, MP12.607 TO KY3116 NORTH, MP17.520 PROJECT NO. ____

ETER STATION REFERENCE SPECIAL WEIGHT DATA - GREENUP CO. STA 004 (76)

'er Cent of Trucks 10

.verage Axles per Truck 3.595

.verage 24 Hour Traffic . . . . 1988 ADT 6100

.verage 24 Hour Truck Traffic=(1) x (3) . . . . ——

.verage 24 Hour Truck Traffic at End of 8 Year Period= 610

verage Axles per Truck at End of 8 Year Period = (2) + 0.08 . . . . 3.675

'otal Axles in 8 Years = (5) x (6) x 365 x 8 6,545,910

	(B) Total Axles (7)	(C) % of Total Axles From Load Sta.	(D) Correction	(E) Corrected % of Total Axles (C) + (D)	(F) Total Axles by Weight Class (B) x (E)	(G) EWL Factor	(H) EWL for Two Directions (F) x (G)
	6,545,910	15.125	0.04	15.165	992,687	1	992,687
	"	7.659	0.05	7.709	504,624	2	1,009,248
	"	8.333	0.11	8.443	552,671	4	2,210,684
	"	8.719	0.06	8.779	574,665	8	4,597,320
	"	4.817	0.04	4.857	317,935	16	5,086,960
	"	2.842	0.02	2.862	187,344	32	5,995,008
½	"	2.264	0	2.264	148,199	64	9,484,736
½	"	1.927	0	1.927	126,140	128	16,145,920

TOTAL EWL for 8 year period (two directions) 45,522,563

$\frac{45,522,563}{20} \times 0.497 - (1.84 + 1.42 \times 0.10) \times 10^{-6} \times 6100$ 1.4x10^6 EAL's

$2,276,128 \times 0.497 - (1.982 \times 0.000001 \times 6100)$

$2,276,128 \times 0.485 = 1,103,922$ EALs/LANE (4LANE-2WAY)

10-24-84

'OTE: THIS ESTIMATE DOES NOT ASSUME THE PROPOSED BRIDGE ACROSS THE GREENUP DAM OR THE PROPOSED AA HWY.

TRAFFIC VOLUME GROUP 3000 ∤

Y Greenup ROAD NAME Ashland- So. Portsmouth ROUTE NO. US23

CT LIMITS From KY3116 North, MP 17.520, To 1.2 mi North of KY1043 South (MP 20.200) PROJECT NO. ______

METER STATION REFERENCE Special Weight Data- Greenup Co. Sta 004 (76)

Per Cent of Trucks 11

Average Axles per Truck 3.595

Average 24 Hour Traffic . . . . 1988 ADT 5100

Average 24 Hour Truck Traffic=(1) x (3) . . . . ______

Average 24 Hour Truck Traffic at End of 8 Year Period= (1) x (3) . . 560

Average Axles per Truck at End of 8 Year Period = (2) ∤ 0.08 . . . . 3.675

Total Axles in 8 Years = (5) x (6) x 365 x 8 6,009,360

	(B) Total Axles (7)	(C) % of Total Axles From Load Sta.	(D) Correction	(E) Corrected % of Total Axles (C) ∤ (D)	(F) Total Axles by Weight Class (B) x (E)	(G) EWL Factor	(H) EWL for Two Directions (F) x (G)
	6,009,360	15.125	0.04	15.165	911,319	1	911,319
	"	7.659	0.05	7.709	463,262	2	926,524
	"	8.333	0.11	8.443	507,370	4	2,029,480
	"	8.719	0.06	8.779	527,562	8	4,220,496
	"	4.817	0.04	4.857	291,875	16	4,670,000
	"	2.842	0.02	2.862	171,988	32	5,503,616
½	"	2.264	0	2.264	136,052	64	8,707,328
½	"	1.927	0	1.927	115,800	128	14,822,400
					TOTAL EWL for 8 year period (two directions)		41,791,163

1.31×10^{4} EAL's

$\frac{41,791,163}{20} \times 0.497 - (1.84 + 1.42 \times 0.11) \times 10^{-6} \times 5100$

$2,089,558 \times 0.497 - (1.996 \times 0.000001 \times 5100)$

$2,089,558 \times 0.487 =$ 1,017,615 EALs/Lane (4Lane-2way)

10/24/84

[signature]

Note: This estimate does not assume the proposed bridge across the Greenup Dam or the proposed AA Hwy.

TRAFFIC VOLUME GROUP 3000 +

Y *Nicholas* ROAD NAME *Paris-Maysville* ROUTE NO. *US68*

CT LIMITS *From MP10.420 to Robertson Co. Line (MP 12.211)* PROJECT NO. ____

METER STATION REFERENCE *1978-80-82 Rural Data - Robertson Co. Sta 252(81)*

Per Cent of Trucks *17*

Average Axles per Truck *3.982*

Average 24 Hour Traffic . . . . $\frac{2300(84)+2900(92)}{2}$ = ... *2600*

Average 24 Hour Truck Traffic=(1) x (3) . . . . ——

Average 24 Hour Truck Traffic at End of 8 Year Period= *440*

Average Axles per Truck at End of 8 Year Period = (2) + 0.08 . . . . *4.062*

Total Axles in 8 Years = (5) x (6) x 365 x 8 . . . . *5,218,858*

	(B) Total Axles (7)	(C) % of Total Axles From Load Sta.	(D) Correction	(E) Corrected % of Total Axles (C) + (D)	(F) Total Axles by Weight Class (B) x (E)	(G) EWL Factor	(H) EWL for Two Directions (F) x (G)
	5,218,858	*17.575*	0.04	*17.615*	*919,302*	1	*919,302*
	"	*9.661*	0.05	*9.711*	*506,803*	2	*1,013,606*
	"	*10.516*	0.11	*10.626*	*554,556*	4	*2,218,224*
	"	*10.754*	0.06	*10.814*	*564,367*	8	*4,514,936*
	"	*5.023*	0.04	*5.063*	*264,231*	16	*4,227,696*
	"	*2.360*	0.02	*2.380*	*124,209*	32	*3,974,688*
½	"	*1.051*	0	*1.051*	*54,850*	64	*3,510,400*
½	"	*0.228*	0	*0.228*	*11,899*	128	*1,523,072*
					TOTAL EWL for 8 year period (two directions)		*21,901,924*

6.8x10^5 EAL's

$\frac{21,901,924}{20}$ *x 0.5 = 547,548 EALs/Lane (2Lane-2way)*

10-24-84

[signature]

APPENDIX 2

DRAFT

Field Trip Report

Pavement Rehabilitation and Design Team

Kentucky Review

by

Reuben S. Thomas

Paul Teng

Tom Everett

November 18, 1985

Purpose of Trip

To meet with Region 4, Kentucky Division, and Kentucky Department of Transportation for a review of I-64 and U.S. Route 23 in Kentucky on November 13-14, 1985.

Contacts

Kentucky Department of Transportation:

Gene B. Drake		Design
Harrison Evans		Maintenance
A. B. Magee		Design, Special Projects
Edward L. Minter		Materials
David Hughes		Construction
Cyrus S. Layson		Assistant State Highway Engineer
Larry Epley		Materials
Duane Evans		Specifications
Kentucky Division:	Paul Doss	District Engineer
Region 4:	Johnny L. Morris	Regional Pavement Specialist
Washington Headquarters:	Reuben Thomas	Pavement Branch, Engineering
	Paul Teng	Management and Contract Administration Branch, Highway Operations
	Tom Everett	Highway Engineer Trainee

Review Contents

This field review consisted of a review of a recent concrete pavement restoration (CPR) project and a potential concrete pavement rehabilitation project on I-64 and a 25 mile potential rehabilitation project on a 4-lane divided flexible pavement on U.S. Route 23 from Ashland to South Portsmouth. In the following sections, the pavement projects will be discussed along with recommendations. It should be noted that these observations are based upon a limited review. We do not feel that we can briefly examine a pavement in a short time and give the State the ultimate solution for a problem its engineers have been investigating for many months. We would like to provide an outside opinion and items for consideration that may be beneficial to the State in determining its final rehabilitation strategy.

For any pavement rehabilitation project, the States are encouraged to follow the approach for an engineering and economic analysis as outlined in Mr. Barnhart's November 15, 1983, memorandum. Briefly, this includes the following steps:

a) Establish existing condition of pavement.
b) Identify distress.
c) Determine causes of distress.
d) Develop feasible alternatives.
e) Conduct economic (life cycle cost) and engineering analysis of each alternative.
f) Select most appropriate alternative.
g) Design rehabilitation alternative.
h) Follow-up evaluation.

IV. **Project Review**

A. I-64 from U.S. Route 60 to I-75

This is a 10-inch meshed reinforced portland cement concrete pavement with a 50-foot joint spacing and dowels on a 6-inch dense graded limestone aggregate subbase over a 2-foot limestone rock subgrade. The shoulder is 2 inches of asphaltic concrete over dense grade aggregate. The project was opened to traffic in 1973.

There is transverse mid-slab cracks throughout the project. Approximately 40 percent of the panels have one or more cracks. The cracks are spalled and several of the observed cracks were faulted in the range of 1/4 to 3/16 inches.

The transverse joints are in good condition. The joint sealant is deteriorating. There was some indication from the State representatives that the joints are not working. Our observations confirmed that the width of joint was consistent throughout and there has not been much movement. The longitudinal joint was not sealed and there was a drop-off at the edge of the shoulder. The ride is satisfactory and outside of the transverse mid-slab cracks, the concrete is sound.

The State is faced with the problem of whether to rehabilitate this project now or let it go for a few more years. As a rule of thumb, the State does CPR on projects when the cost is less than $300,000 per mile.

It is our belief that it is not feasible to repair all of the mid-slab cracks. It is recommended that the State closely monitor the cracks throughout this section over the next year. If the majority of cracks stay tightly closed as now exists, then the State may want to consider repairing only the faulted cracks. However, if more cracks open up and fault, then it would be feasible to let the pavement deteriorate further over the next few years before initiating a major reconstruction project such as recycling, structural overlay, or crack and seat.

Since the transverse joints looked like they have not worked since the original construction, any repair work on the 50-foot long slab should carefully consider the consequences of re-establishing slab continuity. If the joints are not functional, crack repair of full depth patching without allowing movement <u>could</u> turn the pavement into a CRCP. However, the steel percentage in the existing pavement is not adequate for a CRCP to function. Therefore, the repaired slab <u>could</u> create further new transverse cracks.

There was a comment made during our review that the installation of underdrains might be feasible. The Team did not observe any pumping and believes that underdrains are not warranted at this time. The team was advised by the State engineers that Monsanto type of edge drain was installed in an adjacent CPR Section (item B below). Thus far the drainage system is working. The State may wish to seal the longitudinal shoulder joint for this section and study the moisture related distress indicators (such as pumping, faulting, etc.) of the two pavement sections.

B. I-64 from U.S. Route 60 at Mt. Sterling to Route 799

This is a 32-mile concrete pavement rehabilitation. The original pavement was a 10-inch meshed reinforced jointed concrete pavement on a 6-inch dense graded limestone base on earth subgrade. The joint spacing was 50-feet and has dowels. The asphalt concrete shoulders are in good condition.

4" PE pipe

This CPR project included sealing the joints, installing underdrains ~~(Monsanto-type)~~, full depth PCC patching, and spall repair. The project was just completed this year.

The pavement ride was satisfactory; however, some patches were rough. There were a few places where the pavement had broken up in swelling clay areas and asphalt concrete patches have been installed.

Boyd Co. Line

C. U.S. Route 23 from Milepost 3.1 just north of ~~Ashland~~ north to Milepost 28.8 at South Portsmouth.

The attached map shows the route location and provides data on Federal-Aid project number, contractor, award date, and typical section. The projects along this route were constructed between 1972 and 1976. The typical section for this 4-lane divided flexible highway averages 1-inch bituminous surface, 5 1/2-inches bituminous base, and 10-inches dense graded aggregate. Slag and limestone aggregate were used throughout the length of these projects. Sections of the route have been covered with between 1 and 3 applications of chip seal over the past few months. There are also several bituminous maintenance patches. The shoulders consist of untreated aggregate.

Prior to the chip seal, there were transverse cracks throughout the project on a regular pattern of 30-50 feet. In areas not covered by chip seal, these cracks were still visible and in many cases have deteriorated under loading to form block-like crack patterns. These cracks are frequent and severe.

There also exists longitudinal cracks and block cracks in the wheelpaths. The right lane is also rutted severely in several locations.

The chip seal has worn off in many places, creating slick places in the wheelpath. The chip seal over the sections of open graded friction course between mileposts 17.7 and 20.3 looks good. However, in most cases the cracks are reflecting through the chip seal.

Between mileposts 20.3 and 22.4, there are no transverse cracks visible in either the northbound or southbound roadways. There are longitudinal cracks due to loading in the southbound lanes. It should be noted that this section has limestone in dense graded aggregate base, bituminous base and surface courses.

A meeting was held on the night of November 13 to present the viewpoints of the different offices of the State as to the reasons behind the deterioration of this pavement. It was generally agreed that the longitudinal block cracking and rutting was due to loading. This route, especially the northbound lanes, have been subjected to extreme truck loadings from coal trucks. Overloaded trucks are not uncommon on this route.

One individual noted that during construction in sections where the limestone dense graded subbase sections, the limestone was deficient in the minus 200 sieve. This difference was made up by the addition of flyash. He noted that the flyash may have set up with the limestone creating a semi-rigid base which had a crack pattern similar to rigid pavements and which reflected through the flexible surface. Flyash was also added to the slag dense graded aggregate base.

It was indicated that since the freeze in 1977, they have been seeing more transverse cracking. One individual stated that the transverse cracking is due to temperature cracking and that this is not restricted to this project, but is common throughout the State.

A detailed analysis by Mr. James Havens is attached.

The Team noted a distinct difference betwen the sections with limestone aggregate and slag aggregate. It is possible that this factor in combination with temperature cracking can explain the severe transverse cracking that exists along this route. It is recommended that investigation trenches be cut at several locations for two reasons: First, to determine if rutting is limited to the surface layer and is not associated with deformation of the dense graded aggregate base; secondly, to determine if the transverse cracks are reflecting up from the dense graded aggregate base. Trenches should be cut both in the slag aggregate and limestone aggregate sections.

In addition, it was suggested that a detailed crack survey be conducted to determine which material has the worst condition. The Team concurs in this suggestion.

Roadrater readings have been taken on this route from milepost 3.1 to milepost 20. 24. Using Kentucky's design procedure, overlay thicknesses between 2.7 and 0.4 inches have been determined. It is recommended that roadrater readings be taken for the remaining portion of the project.

From the Team's observation, it is felt that any overlay of less than 3 inches on the severely cracked section is not feasible. There are sections that are not cracked badly where a thinner overlay may be satisfactory, but for the majority of the route, a thicker overlay seems justified.

It was discussed if additional chip seals should be applied to untreated sections to seal cracks. It was indicated that 1-inch of bituminous overlay could be placed for the price of a chip seal.

A typical practice in adjacent States like North Carolina that have experienced similar rutting and cracking problems is to mill off a layer of the distressed old pavement and replace it with a thicker structural overlay. Using the Falling Weight Deflectometer, North Carolina was able to determine that the milled off 2.5 inch old pavement was structurally equivalent to approximately 1 inch of new pavement.

There was some indication that the State did not want to mill off the recently placed chip seal. However, this is a feasible alternative, especially for sections where chip seals has not been placed.

The following are possible rehabilitation alternatives to consider:

(1) Asphalt concrete overlay.
(2) Mill off 1-2 inches and place asphalt concrete overlay.
(3) Recycle.
(4) Unbonded PCC overlay.

In addition, it was noted that the shoulders along this project are not surfaced. For a route with this traffic, the Team recommends a higher type shoulder of acceptable geometric standards, i.e. 10-foot asphalt concrete shoulders.

The project along this 25-mile section are in different stages of deterioration. Several different alternatives may be feasible. It is known that as a pavement deteriorates, it costs more to repair. Some of these projects need corrective work to prevent further deterioration. It is recommended that corrective action be taken on the worst section as soon as possible.

V. <u>Closing Remarks</u>

During the field trip, we observed a close working relationship between our Division Office and the State, and also among all the various offices in the State transportation department. Everybody is interested in how to improve the performance of the pavements and what has caused the distress thus far. We think this spirit of cooperation is excellent and we look forward to continuing to work with the State and our field offices whenever we can provide assistance.

Project / Station	CBR	EAL	Pavement Section	Alternate	Alternate	Overlay	Milepost	Design EAL
…D. 12-2-7… / …. ROAD OILING & …HANDS & WEBB		EAL = 4…	13" BGA 6¼" B.S. 5/8" SAS Tp. II Slag Aggr. - BGA, B.B., B.S. - SAS Tp II	FB BGA 3" B.B. 1" B.S.	5" BGA		M.P. 26.9	EAL 8.5x10^6 11/8/85
206 + 00	CBR=5							
…D 537(67) 712 MILES …D. 10-30-73 HANDS & WEBB		CBR=9 Const. Rev.	12" BGA 6¼" B.B. 1" B.S. Ls. Aggr. - BGA Slag Aggr. - B.B., B.S.	FB BGA 3" B.B. 1" B.S.	5" BGA			(20 yr) EAL 7.6x10^6 11/8/85
296 + 50								
…D 537(65) 718 MILES …D. 7-26-73 …TTS & CALL CONST.	320 + 00		9½" DGA 5¼" B.B. 1" B.S. Ls. Aggr. - BGA Slag Aggr. - B.B., B.S.	—	5" BGA		M.P. 23.0	
440 + 00								
…D 537(55) …82 MILES …. 8-17-72 …. ROAD OILING INC. & …TTS & CALL	CBR=9	EAL = 20-40	9½" BGA 5¼" B.B. 1" B.S. Ls. Aggr. - DGA, B.B., B.S.	FB DGA 3" B.B. 1" B.S.	5" BGA			
550 + 00							M.P. 20.26	
…I 537(63) …03 MILES …. 5-7-73 …ZACK BROS. CONST. CORP.			9½" DGA 5¼" B.B. 1" B.S. Ls. Aggr. - DGA, B.B., B.S. 3/4" OG FC	FB DGA 3" B.B. 1" B.S.	5" DGA	B=1.8" S=1.8"		(20 yr) EAL 5.3x10^6 11/8/85
687 + 48.76 BK. =580 + 73.93 AH.	CBR=5	CBR=9 Const Rev	12" DGA 5¼" B.B. 1" B.S. Ls. Aggr. - DGA, B.B., B.S.	—	5" DGA	B=0.4" S=1.4"	M.P. 17.56	
537(54) 16 MILES . 5-26-72 MARBLE CLIFF QUARRIES CO.	700 + 00						MP 14.7	
	CBR=9	EAL = 20-40	9" DGA 5¼" B.B. 1" B.S. Lw. Aggr. - DGA, B.B., B.S.	FD DGA 3" B.B. 1" B.S.	5" DGA	B=0.6" S=1.4"		20 Yr. EAL 7.2x10^6 10/21/85
851 + 00							MP 12.6	
537(53) …3 MILES 5-26-72 …S & CALL & …ANSON BRIDGE			11" DGA 5¼" B.B. 1" B.S. Ls. Aggr. - DGA Slag. Aggr. - B.B., B.S.	FD DGA 3" B.B. 1" B.S.	5" DGA	B=1.8" S=2.2"	MP 11.2	
942 + 00								
537(52) 2 MILES 7-5-72 …OAD OILING	CBR=6	EAL = 20-40					MP 9.6	
1100 + 50			1085 + 00 G, D, S 1100 + 50 G, D			B=2.4" S=2.7"		20 Yr. EAL 8.9x10^6 10/21/85
…37(56) … MILES 7-26-73 …AD OILING	CBR=9		11" DGA 5¼" B.B. 1" B.S. 9" DGA 5¼" B.B. 1" B.S. Slag Aggr. - DGA, B.B., B.S.	FD DGA 3" B.B. 1" B.S. FD DGA 3" B.B. 1" B.S.	5" DGA 5" DGA			
1346 + 74.81						OVERLAY REQUIRED 12/84 (8 Yr. Des	MP 3.1	

KENTUCKY TRANSPORTATION RESEARCH PROGRAM

UNIVERSITY OF KENTUCKY

College of Engineering
Transportation Research Building
533 South Limestone
Lexington, Kentucky 40506-0043
Telephone: 606-257-4513

November 8, 1985

H-2-89

Mr. C. S. Layson, P.E.
Assistant State Highway Engineer
Bureau of Highways
Department of Transportation
Frankfort, Kentucky 40622

Subject: Pavement Inspection Team; C. S. Layson, A. B. Magee, E. B. Drake, J. H. Havens, October 10, 1985, US23, Ashland-South Shore (Portsmouth).

Dear Mr. Layson:

Two types of defects were obvious: rutting and transverse cracking. The rutting was directly and irrefutably caused by extremely heavy trucks hauling coal to Portsmouth (and beyond). The hauling extends from Louisa and points in Martin, Johnson, and perhaps Floyd Counties. Hauling here was interrupted only by closure of the suspension bridge (for re-cabling, in 1978-1979) at South Shore. The transverse cracking is not associated with loading. A highway bridge crossing Greenup Dam will be opening soon, and coal truck traffic may cross the River at that point rather than at South Shore.

The rutting is systematic and can be modeled by computer programs presently at hand. The pavement structures were tested last year and processed through other programs to determine overlay requirements. Those requirements were in the order of 1.5 inches to extend the service life another eight years. Milling or leveling and wedging would be required to correct the rutting.

Rutting varies along the road and is a maximum of about 1.5 inches. Numerous coal-hauling trucks have plied the road. Each truck makes the rut a little deeper. The deformation (non-recoverable shear) occurs in the upper 3 to 5 inches of the asphaltic concrete. This has been demonstrated by trenching and inspecting exposed cross sections of the pavements. The most recent case was the Purchase Parkway (Ref. Research Report UKTRP-84-28). Just previous to that was US23, just north of Louisa ((Research Report UKTRP-84-1; "Rutting: A Case Study (US23; 1.5 miles north of Louisa)), January 1984. Prior histories are given there also. Coal trucks now are reportedly hauling 60 to 80 tons (payload) per trip. Most recently they caused rutting on a new section of US23, between Lowmansville and Louisa.

Transverse cracking persisted throughout. The frequency ranged between

16 and 57 per mile; thus, the interval ranged between 330 feet and 92.6 feet. It is theorized that the interval is governed by the tensile strength of the pavement at the first onset of critical shrinkage. Shrinkage, here, is due to thermal contraction. Temperature cracking is probably more the rule than the exception in Kentucky. A case in point is the Purchase Parkway (reported in 1984). Of course, the spacing varies from place to place, and the width of the cracks varies.

The horizontal tensile force in a pavement is $F_t = \sigma A$, where σ = tensile stress, A = say 1 sq. ft. or 144 sq. ins. The resistance to sliding (that is the force of friction) is given by $F_t = fWL$, where W is the weight in pounds of a 1-ft cube of pavement and L is the length of pavement. Equating forces:

$\sigma A = fWL$
A = 144 sq. ins.
W = 144 lbs/cu.ft.
f = approximately 1
$L = \sigma$

Therefore, the maximum crack spacing is 2L; and L, in feet, is numerically equal to the tensile strength of the pavement in pounds per square inch (psi).

Sixteen cracks per mile gives a spacing of 330 ft.; L = 165 ft. and σ, therefore, would be 165 psi. Sixty cracks per mile gives a spacing of 88 ft.; L = 44 ft., and σ = 44 psi.

Why is there such a great difference in tensile strength? Shouldn't these pavements have about the same tensile strengths? Yes, they have about the same strengths at low temperatures; but that strength (about 400 psi) is greater than these strengths. Consequently these cracks occurred at more moderate temperatures -- perhaps well above moderate temperatures -- perhaps even warmer temperatures.

It is believed that close-spaced cracks occurred during daily cycling of temperatures in the fall season. The longer-spaced cracks occurred during a cooler period. Differences in properties of the pavements surely influenced the patterns.

Some cracks seemed older and wider than others. The pavements are old enough to present mature crack patterns, but the development of them is lost history.

The pavement is not failing at the cracks. This means that the structure has not been greatly weakened by them or that it needs more overlayment over the cracks. The most significant consideration, therefore, seems to be the problem of reflection cracking of any overlayment. It seems unlikely that any way will be found to prevent the cracks from reflecting through. They might be routed and sealed later if they are considered to be offensive and unsightly. It is important to keep in mind that the purposes of overlayment are to correct for rutting and to extend the service life according to projected traffic.

We could have entitled this report "The Reality of Cracks." Temperature cracking is the principal subject. Expounding further: Are cracks predictable? Yes, they occur almost everywhere unless very soft asphalts are used. Is the spacing of the cracks predictable? Yes, if the tensile strength is known, the equation already cited applies very well. A single reference suffices as an independent, state-of-the-art treatise. It is: "Prediction of Temperature Cracking at Low

Temperatures;" by B. E. Ruth, L. A. K. Bloy, and A. A. Avital; Proceedings, Association of Asphalt Paving Technologists, Vol. 51, 1982.

The section from Sta. 440 to 687 + 48.76 (equals 580 + 73.93 ahead) and to Sta. 851 contains limestone aggregate in the bituminous concretes and in the DGA bases. This appears to be the area where the crack interval was 88 ft. All other sections contained slag in the bituminous base and surface. This is where the close-spacing occurred. Why does slag cause the difference? It has been known for a long time that slags tending to be vesicular absorb oils from the asphalt binder, and that causes drying and hardening of the asphalt. It is not known how much shrinkage accompanies the process. It is possible that some warm temperature fracturing ensues and weakens the tensile properties of the pavement. Otherwise, the crack spacing would or should be about the same as in the limestone sections.

At some cracks, it appeared that "necking down," a phenomenon accompanying ductile fracture, had occurred.

Illustrative photographs are attached hereto.

The all-limestone sections run from Ky 827, down river to Sta. 440. There are two sections downstream (to Sta. 206) which contain limestone in the DGA. Also, there are two sections upstream which contain limestone in the DGA. If these sections are found to have crack-spacing similar to the all-limestone sections, the influence could be attributed commonly to the DGA bases. On the other hand, if the spacings differ, the difference could be attributed altogether to the slag aggregate as described previously.

If the all-slag sections differ from the sections with limestone DGA bases, those differences would be attributable to the slag DGA. Slag is known to have some cementitious qualities and could act somewhat like a weak, cementrated aggregate base or "soil-cement" base (tend to crack at fairly close spacing).

Detailed surveys are needed to resolve the foregoing questions. Sealcoats and overlayments may now obscure the data.

Road Rater deflection tests were made September 26, 1984. Traffic estimates were made 8 years forward, and overlay requirements were determined and reported (by Gary Sharpe, Nov. 30, 1984). Copies of those items are appended and made a part hereof. (Note: EWL´s/32≈ EAL´s)

Meanwhile, double and perhaps triple chip seals have been applied over portions of the road, and full-width overlayment (patching) were being marked for immediate lay-down on other portions farther toward South Shore. The thicknesses of these overlayments would surely exceed one inch and probably equal 1.5 inches in the wheel paths. These overlays, therefore, could approach the thicknesses of overlay required by the analyses of Road Rater data, as reported by Sharpe.

At present, there seems to be both advantages and disadvantages to re-doing Road Rater tests (winter approaching). Design has new estimates of traffic (EWL´s) to extend service life 20 years hence.

Although overlay requirements could be read from Sharpe's graphs (attached); Sharpe, at this writing, has been requested to submit a proposal for the additional work. His proposal will precede or accompany this report.

Respectfully submitted,

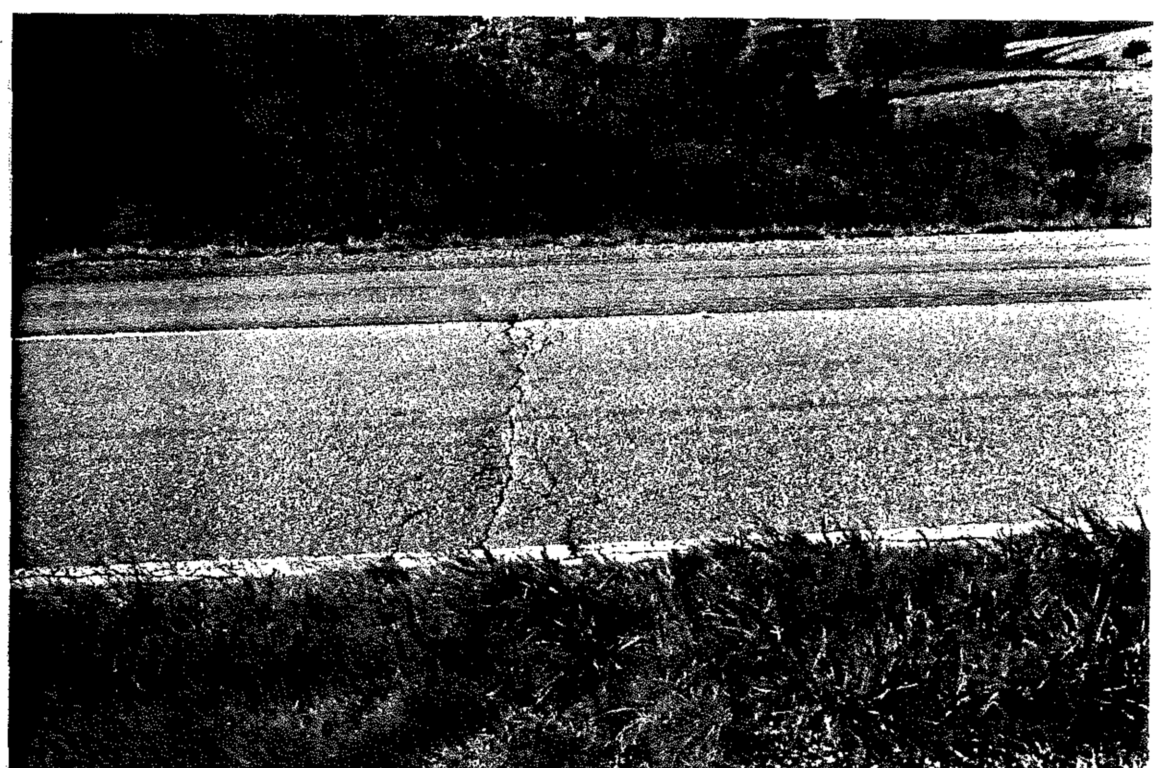
James H. Havens

James H. Havens, P.E.
Associate Director

cc: E. B. Drake
A. B. Magee

Attachments

Rutting: Section Chip-Sealed Previously; Depth Nominally 1.5 inches; Inner Lane not Rutted; Facing South Shore (10-10-85)



Cracking: Example of Prominent Crack; Section Chip-Sealed; Not Bleeding (10-10-85)

Section toward South Shore; Chip-Sealed
Aggregate Loss Seems Extensive (10-10-85)

H-5-63

KENTUCKY TRANSPORTATION RESEARCH PROGRAM

UNIVERSITY OF KENTUCKY

College of Engineering
Transportation Research Building
533 South Limestone
Lexington, Kentucky 40506-0043
Telephone: 606-257-4513

March 31, 1986

Mr. E. B. Drake, P.E.
Transportation Engineering Branch Manager
Division of Design
Department of Highways
Kentucky Transportation Cabinet
Frankfort, Kentucky 40622

Dear Mr. Drake:

Subject: Transmittal of Overlay Thickness Recommendations
US 23, Greenup County: MP 6.0 to MP 28.8

Enclosed are two tables summarizing the findings of overlay thickness design recommendations for the subject sections of US 23 in Greenup County. Thickness design recommendations were determined for each of ten sections for each of the northbound and southbound directions.

Overlay thickness calculations were determined on the basis of resilient modulus testing of asphaltic concrete cores obtained in the field, deflection testing using the KTRP Model 400 Road Rater, and in-place and laboratory California Bearing Ratio (CBR) test conducted on in-situ materials in the field and "bag samples" of subgrade and dense graded aggregate (DGA) samples obtained from the two "trenches" cut in the field.

The findings and analysis procedures for the above tests will be summarized in a report currently being prepared. Completion is expected within the next four to five weeks. Following are some general conclusions and recommendations which will be presented and supported in the aforementioned report:

1. Thickness design recommendations are presented in the attached tables.

2. A minimum thickness of asphaltic concrete surfacing is recommended for all sections even though structural evaluations indicate no need for overlay from a structural perspective. Resurfacing is recommended because of the

observed cracking throughout the entire area. Much of the observed cracking is thought to be temperature-related and not structurally related. Deflection testing apparently support this conclusion. Resilient moduli testing indicate relatively stiff and brittle asphaltic concrete material which may also contribute to the observed cracking. The relatively high resilient moduli (400 ksi to 1000 ksi) also apparently contributes to the low deflections and apparent stiff structural conditions. An 80th percentile resilent modulus of 490 ksi was determined for resilient modulus tests. A design resilient modulus of 480 ksi was selected. Deflection measurements were used in combination with resilient moduli for each design section to determine the design subgrade modulus for each section. Design moduli were verified by findings from destructive evaluations of materials and in-place CBR tests.

3. A crack-relief layer of some type is recommended for placement between the existing surface and the overlay thickness. The crack relief layer is recommended because of the observed cracking in the existing pavement surface and the potential for reflective cracking in the asphaltic concrete overlay. This may present a good opportunity for experimentation with the use of the polymer asphalt and aggregate layer which has been used with some apparent success on the pozzolanic base sections of the Man-O-War Boulevard in Lexington.

Please contact this office if additional information is required or if additional evaluations are required.

Sincerely,

Gary W. Sharpe

Gary W. Sharpe, P.E.
Chief Research Engineer

GWS:gws
Enclosures
cc: C. S. Layson
B. L. Wheat
H.Evans
R. L. Rizenbergs
J. H. Havens
R. C. Deen

TABLE 1: OVERLAY THICKNESS DESIGN RECOMMENDATIONS
NORTH US 23, GREENUP COUNTY

Section	Beginning Milepoint	Ending Milepoint	Design Parameters: Design EAL x 10^6	E_{ac} (ksi)	E_{dga} (ksi)	E_{sub} (ksi)	T_{ac} (in)	T_{dga} (in)	Overlay (in)
A	3.1	7.7	8.9	480	28.6	10.2	6.5	9.0	2.5
B	7.7	11.2	8.9	480	28.3	10.1	6.5	11.0	2.0
C	11.2	12.6	7.2	480	41.6	16.0	6.5	11.0	0.0
D	12.6	14.7	7.2	480	34.8	12.8	6.5	9.0	1.5
E	14.7	17.7	5.3	480	33.3	12.2	6.5	12.0	0.5
F	17.7	20.3	5.3	480	26.6	9.3	6.5	9.5	2.0
G	20.3	22.4	5.3	480	43.9	17.1	6.5	9.5	0.0
H1	22.4	23.0	5.3	480	32.2	11.8	6.5	9.5	1.0
H2	23.0	25.1	7.6	480	32.2	11.8	6.5	9.5	2.0
I	25.1	26.8	7.6	480	34.8	12.8	6.5	9.5	1.0
J	26.8	28.8	8.5	480	48.1	18.7	6.5	13.0	0.0

E_{ac} = Modulus of Elasticity For Asphaltic Concrete
E_{dga} = Modulus of Elasticity For Dense Graded Aggregate
E_{sub} = Modulus of Elasticity For Subgrade
T_{ac} = Thickness of Existing Asphaltic Concrete
T_{dga} = Thickness of Existing Dense Graded Aggregate

TABLE 2: OVERLAY THICKNESS DESIGN RECOMMENDATIONS
SOUTH US 23, GREENUP COUNTY

			Design Parameters						
Section	Beginning Milepoint	Ending Milepoint	Design EAL x 10^6	E_{ac} (ksi)	E_{dga} (ksi)	E_{sub} (ksi)	T_{ac} (in)	T_{dga} (in)	Overlay (in)
A1	3.1	6.0	8.9	480	24.4	8.4	6.5	9.0	3.5
A2	6.0	7.7	8.9	480	19.4	6.4	6.5	9.0	4.5
B	7.7	11.2	8.9	480	25.3	8.8	6.5	11.0	2.5
C	11.2	12.6	7.2	480	33.1	12.1	6.5	11.0	1.0
D	12.6	14.7	7.2	480	35.4	13.2	6.5	9.0	1.5
E1	14.7	16.0	5.3	480	39.7	15.1	6.5	12.0	0.0
E2	16.0	17.7	5.3	480	38.5	14.6	6.5	12.0	0.0
F	17.7	20.3	5.3	480	39.9	15.2	6.5	9.5	0.5
G1	20.3	21.1	5.3	480	40.3	15.2	6.5	9.5	0.5
G2	21.1	22.4	5.3	480	37.2	14.0	6.5	9.5	0.5
H1	22.4	23.0	5.3	480	32.7	13.4	6.5	9.5	1.0
H2	23.0	25.1	7.6	480	32.7	13.4	6.5	9.5	1.5
I	25.1	26.8	7.6	480	40.2	15.3	6.5	9.5	0.0
J	26.8	28.8	8.5	480	50.8	20.5	6.5	13.0	0.0

E_{ac} = Modulus of Elasticity For Asphaltic Concrete
E_{dga} = Modulus of Elasticity For Dense Graded Aggregate
E_{sub} = Modulus of Elasticity For Subgrade
T_{ac} = Thickness of Existing Asphaltic Concrete
T_{dga} = Thickness of Existing Dense Graded Aggregate

INTER-OFFICE MEMO

TC 10-200
1/84

C. Lexlie Dawson
~~[illegible]~~
SECRETARY

COMMONWEALTH OF KENTUCKY
TRANSPORTATION CABINET
FRANKFORT, KENTUCKY 40622

MARTHA LAYNE COLLINS
GOVERNOR

MEMO TO: George Asbury, Director
Division of Maintenance

ATTENTION: Harrison Evans, Assistant Director
Division of Maintenance

FROM: Ed Minter

DATE: February 7, 1986

SUBJECT: Recommendation for U.S.-23 Segment
between M.P. 3.1 and M.P. 28.8

Exclude from the section referenced above the areas that were paved last year. The section of open-graded pavement that was chip-sealed last year could be delayed for a year or two. A second chip-seal course could extend its service life for several years.

I recommend that as a first action all pot-holes that have formed be repaired. As the second effort I recommend that all cracks that are larger than 1/8 inch be filled with polymerized emulsion (CRS-2S) and blotted with No. 8 or 9 M slag aggregate. After the emulsion has cured the excess aggregate should be swept or vacuumed off the pavement. Traffic could then be allowed to use the lane. Obviously only one lane could be sealed at a time in order not to disrupt the flow of traffic.

After all cracks larger than 1/8 inch are filled I recommend that a chip-seal application be applied. This would provide a filler, sealer, and some stress relief to future bituminous overlays. The polymerized emulsion (CRS-2S) should be applied at .45 gallons per square yard followed by sufficient No. 8 or 9 M stone to cover the emulsion one (1) stone thick. Rolling of the aggregate chip should be accomplished by pneumatic tired rollers at a maximum speed of 5 miles per hour for a minimum of three passes. The first pass must be made immediately behind the aggregate spreader. No more than 5-8% excess aggregate should be applied. All excess stone should be swept off after the emulsion has cured. This is important as a safety precaution and to keep the unbonded aggregate from dislodging the bonded aggregate.

After all loose aggregate has been removed I recommend placement of enough bituminous hot mix to fulfill the recommendation made by Gary Sharp.

The sand asphalt section at Southshore does not show as much distress as other sections. To simply seal the existing cracks would suffice. The cracks could be sealed as described earlier except that a smaller slag aggregate than an 8 or 9 M could be used to reduce the bump height over cracks.

I am attaching a summary of our study of U.S. 23 M.P. 3.1 to M.P. 28.8.

Attachment

cc: J. McChord
L. Epley
J. Hinton
G. Sharp

SUMMARY OF STUDY OF U.S. 23
from
ASHLAND M.P. 3.1
to
SOUTHSHORE M.P. 28.8

In early 1985 an effort was begun to save portions of U.S. 23 from further severe damage caused by many factors but mostly by water and heavy loads. It was important to keep the expense of those maintenance activities as low as possible. The monetary figures that I remember was about $400,000 maximum available funds.

It was decided that a polymerized emulsion chip-seal would be employed to try to fill as many cracks as possible. As many as three chip-seal applications were required to fill some cracked areas. After the chip-seal a hot-mix surface course was applied at thicknesses of 1-3 inches. Obviously there was not enough money available to treat the entire 10 miles of pavement that was in the poorest condition. We therefore treated the worst sections first which meant treating the outside lane with chip-seal and covering only part of the chip-seal with hot-mix bituminous pavement. At present I feel the work done to have been successful.

We now are looking at the remainder of the roadway on U.S. 23 as identified by the subject mile points. Collectively I hope we can formulate the best maintenance strategy possible.

My recommendation must begin with the existing cracks. Before any subsequent work all cracks should be sealed or filled. I realize the difficulty involved in accomplishing a seal of pavement cracks but they should at least be filled. If we use a polymerized emulsion crack sealer and chip I believe we have an excellent opportunity of sealing as well as filling the cracks on U.S. 23. The openness of the slag particles that compose the old cracked pavement should have a high affinity for asphalt. The added resistance to cold temperature cracking of the polymerized emulsion residue should also retard recurrence of the old cracks. It would be impossible to individually seal all cracks on U.S. 23 but the ones that are one eighth inch or larger should be attempted. The smallest cracks could be adequately filled by chip-sealing the entire width of pavement after the large cracks and pot-holes are first filled. After the final chip-seal with polymerized emulsion is complete I recommend waiting for at least one year before further rehabilitation of the pavement is attempted. The reason for this delay would be to identify those cracks, pot-holes, and weak spots that need more attention prior to overlaying with a new bituminous surface course.

Gary Sharp is trying to determine the pavement's present load bearing capacity in order to calculate the depth of bituminous concrete overlay needed to bring the pavement back to required strength.

The Division of Materials took the pavement cores for Gary and at the same time we also took 27 additional cores in an effort to learn more about the failures on U.S. 23.

Mr. Havens calculated the occurrence of cracks on U.S. 23 to have a spacing of 88 feet. Actual observation will corroborate the numbers of 30-50 feet as stated by the Pavement Rehabilitation and Design Team's review made on November 14, 1985. After having observed many sections of the pavement I find that the first transverse cracks were probably spaced 30-50 feet apart but subsequent cracking is more random and the total cracks are often no farther apart than 2-4 feet. Generally, I found that the cracks could be placed in three categories. The first transverse cracks to form were caused by shrinkage or contraction of the pavement. The first cracks probably were clean breaks through all layers of pavement. These breaks occurred much like you would expect concrete cracks to form if no saw joints were made. The second cracks to form were generally parallel to the shrinkage cracks and were probably caused by constant traffic stress. Generally these cracks started in the surface and progressed downward as traffic loading and freeze-thaw action widened them. The third type of crack can be identified as blocking cracks that formed at right angles to the transverse cracks. Their depth is generally shallow and more narrow. As these cracks grow wider, deeper, and more numerous the D.G.A. is more susceptible to water and traffic damage. These blocking cracks are not always parallel to traffic flow but as they become more numerous they also become more random and more numerous in the outside lane wheel tracks. Add to this the slight rutting in most areas which, according to the cores taken, was caused by load deflection and wear and you have a collecting point for water. The trenches made by Gary Sharp's team showed very little deflection of the D.G.A. but eventually the water will begin to erode the D.G.A. allowing the pieces of broken pavement to rock under traffic. If a mistake was made last summer on the U.S. 23 chip seal and resurfacing effort it was failure to first fill all cracks larger than 1/8 inch before the first chip seal course was applied. By doing so we could have adequately filled most cracks with one chip seal course. This would have tied rocking pieces together much better. Instead of filling some cracks we bridged them which may allow some cracks to come back.

Many possible reasons were cited for the formation of the cracks on U.S. 23. Nearly all of the reasons cited may have contributed. I believe that the first transverse cracks were caused by shrinkage of the pavement. Decrease in temperature during one or two very cold winters or the dry weather during the summers of 1983 and 1984 could have had strong shrinking effects on the pavement causing many cracks. I believe however that the first cracks formed before these events and possibly independant of these factors. I am inclined to agree with David Hughes and Larry Epley and cite as the most probable reason the heavy absorption of asphalt by the slag particles. Under ultraviolet light the penetration of asphalt into the slag was very deep. Nearby 1/8 inch absorption was noted in some core slag particles. Most of the absorption probably occurred during mixing and placement of the mix. As the individual particles cooled the asphalt was sucked into the particles therefore producing a lot of shrinkage stress on the pavement very early in its service life. The first cracks may have been unnoticed for years or until freeze-thaw action caused further deterioration. Another factor that points to the age of the first cracks to form is the rounding of the pavement at the crack edge. Since this pavement is so stiff it would have taken a long time for traffic to deflect the pavement at the crack edge. This factor is more noticeable at M.P. 23 or close to Southshore, Ky. the slight depression at the crack is most noticeable as a thump-thump while riding in vehicles over the pavement. The rounded edges are easy to see when you stop and look more closely at the largest transverse cracks. They are noticeable also on the video tapes that have been made of the cracks. Havens referred to these as "necking down" at the cracks in his report dated November 8, 1985. The report by Havens will also explain other factors necessary to an understanding of the U.S. 23 cracking problems.

After looking at the cores, kind of traffic North of Ashland, deflection of the bituminous pavement on U.S. 23 at Louisa, Ky., and various other pavements exhibiting failures I have concluded that the pavement on U.S. 23 may have performed at its peak. It actually performed like a concrete pavement would have performed. The slag absorbed a lot of asphalt leaving the pavement very hard and brittle. If the asphalt film thickness had remained as thick as when first mixed the pavement would have rutted very badly much earlier and required much more maintenance. I had originally thought that the slag selectively absorbed a fraction of the asphalt ie. the most volatile portion, however, after looking at these cores I find that I was wrong. The slag absorbed the asphalt without fractionating it. Both sources of slag used in the original construction absorbed a lot of asphalt but the Northern end appeared to have absorbed the most. The slag particles in the pavement at Southshore appear to have much larger air packets in the aggregate than the south end. Under ultraviolet light the absorbed asphalt appears dark rather than the light brown and bright yellow that is evident when examining bank gravel or limestone asphalt mixes. Mixes that fractionally absorb a part of the asphalt film do not have as much cohesion between particles as is exhibited by the slag mix on U.S. 23. The asphalt left as film coating on aggregate particles is much more viscous and brittle than it would be if the light fractions of asphalt had not been absorbed. On future full depth slag mixes it may be advisable to control expected cracking by sawing at intervals and sealing the saw cuts with a suitable sealant.

At present I have many slides, some pictures, several V.C.R. tapes and 27 cores that are available to persons who wish to study this job more thoroughly than is possible by reading this paper. I enourage your comments.

Edward L. Minter
January 31, 1986

Rec'd 11-14-85

COMMONWEALTH OF KENTUCKY
TRANSPORTATION CABINET
FRANKFORT, KENTUCKY 40622

C. LESLIE DAWSON
SECRETARY
AND
MMISSIONER OF HIGHWAYS

MARTHA LAYNE COLLINS
GOVERNOR

November 8, 1985

Mr. R. E. Johnson, Division Administrator
Federal Highway Administration
P. O. Box 536
Frankfort, Kentucky 40601

ATTENTION: Paul Doss

Dear Mr. Johnson:

SUBJECT: Pavement Rehabilitation and Design Team

This is to acknowledge that our trip is still scheduled for November 13-14, 1985, and reservations have been made in Ashland for you and those listed below to attend the inspection of sections of US 23. Attached is a tabulation of the data we have been able to accumulate from our files pertinent to the investigation. I take this opportunity to put this in your hands prior to the trip for the purpose of study.

We plan to leave sometime the morning of the 13th, and I will call you later about the exact time. Call if you have questions concerning this data, or about the trip.

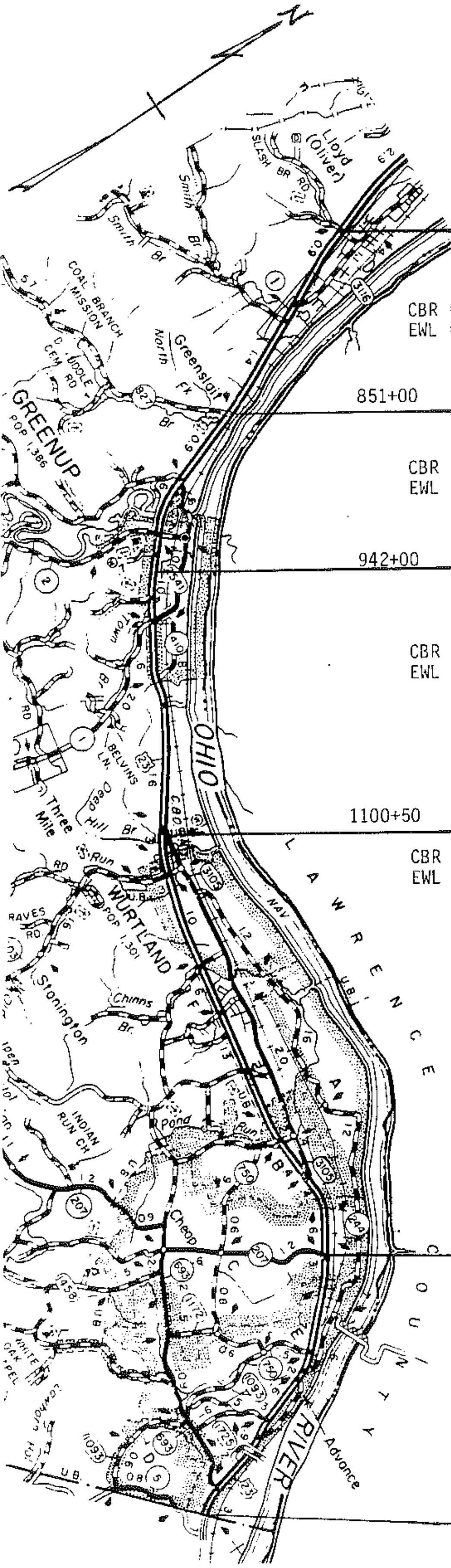
Sincerely,

R. K. Capito, P.E.
State Highway Engineer

E. B. Drake For

By: L. S. Blevins, P. E.
Division of Design

EBD:cjh
cc: C. S. Layson-w/a
J. H. Havens-w/a
Harrison Evans-w/a
L. E. Jewell-w/a
Duane Evans-w/a
E. B. Drake-w/a
Larry Epley-w/a
FHWA Files



STA. 728 + 80 MP 14.7

CBR = 9
EWL = 20-40

A.P.D. 537(54)
Awd. 5-26-72
2.121 Mi. of 5.116 Mi. (Tot.)
MARBLE CLIFF QUARRIES

9" DGA (LS)
6½" BIT (LS)

N=0.4
S=1.4

(20 Yrs.)
EAL
7.2×10^6
10/21/85

851+00 MP 12.6

CBR = 6
EWL = 20-40

A.P.D. 537(53)
Awd. 5-26-72
1.723 Mi.
WATTS & CALL &
RR DAWSON

11" DGA (LS)
6½" BIT (Slag)

N=1.8"
S=2.2"

MP 11.18

942+00 MP 10.7

CBR = 6
EWL = 20-40

A.P.D. 537(52)
Awd. 7-5-72
3.002 Mi.
KY ROAD OILING

11" DGA (LS)
6½" BIT (Slag)

MP 9.6

1100+50 MP 7.7

CBR = 9
EWL = 20-40

A.P.D. 537(56)
Awd. 7-26-73
4.654 Mi.
KY ROAD OILING

9" DGA (Slag)
6½" BIT (Slag)

N=2.4"
S=2.7"

(20 Yr.)
EAL
9.9×10^6
10/21/85

STA. 1346 + 74.81 MP 3.1

AS
CONSTRUCTED

OVERLAY
REQUIRED
12/84
(8 Yr. Des)

MP 0.00

GREENUP CO.
US 23

APPENDIX 3

MEMORANDUM

To: James H. Havens
Associate Director

From: David Hunsucker
Research Engineer Associate

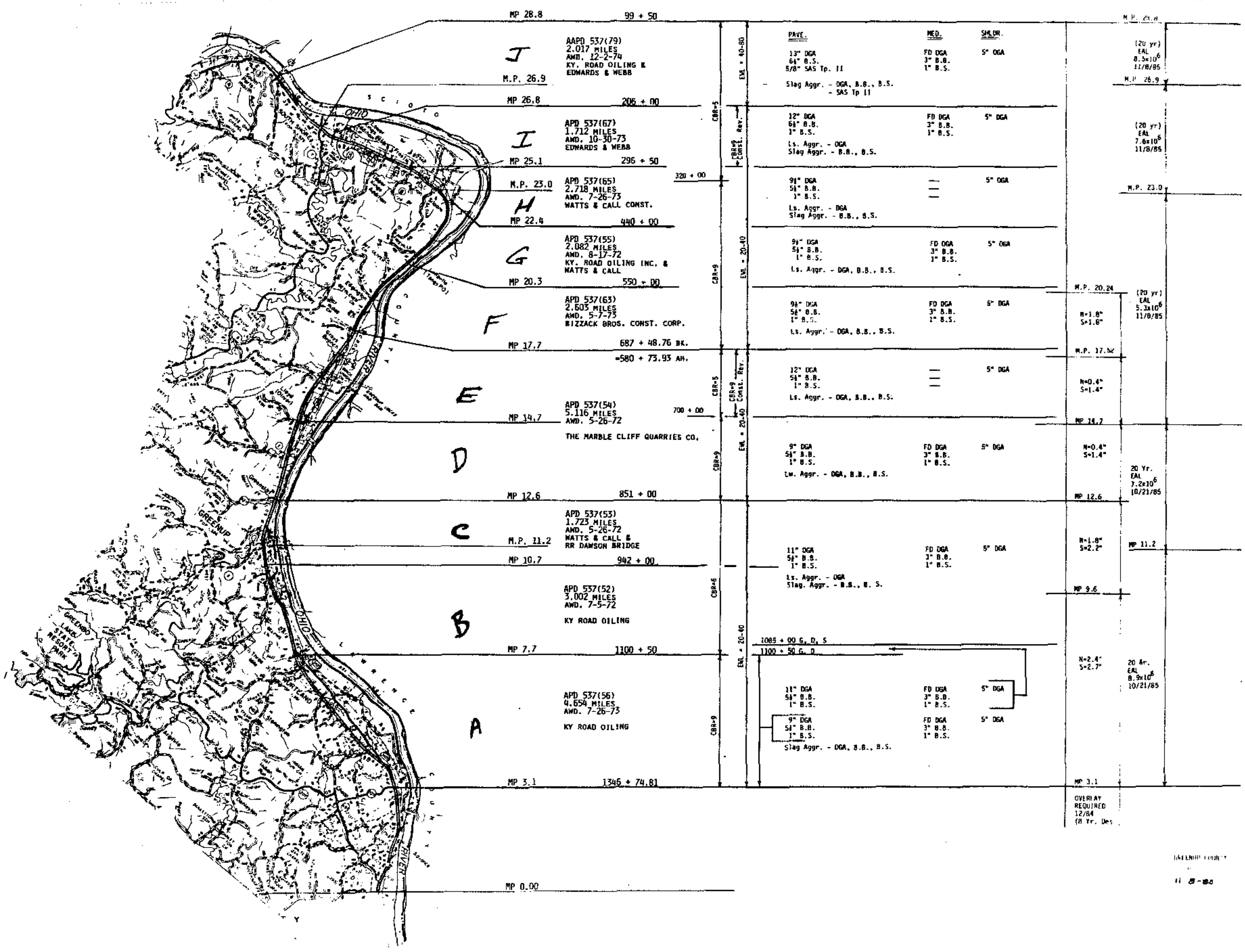
Date: 30 May 1986

Subject: Detailed Crack Survey - - U. S. 23, Greenup County

On 17 and 18 March 1986, Kentucky Transportation Research Program personnel conducted a detailed crack survey encompassing each design section of the subject highway. One thousand foot sections in each design section were arbitrarily chosen for the survey.

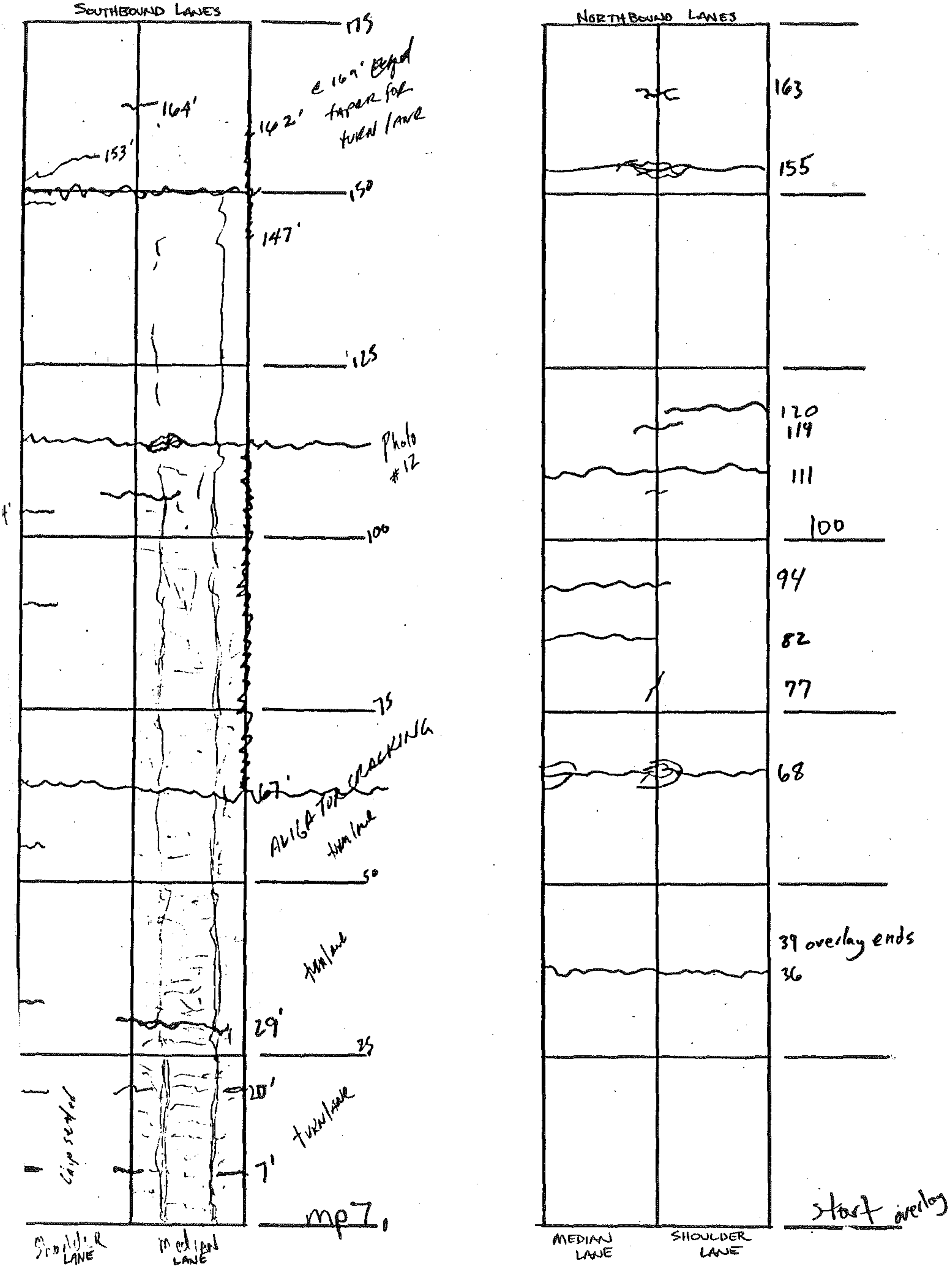
A variety of pavement distresses were observed in both the Northbound and Southbound travel lanes. Those distresses included transverse cracks, longitudinal cracks, aligator cracking, edge cracking, raveling, bleeding, and pot holes.

Results of the detailed crack survey, a summary of the distresses and photographs taken during the survey are attached. The results of this survey will enable one to return to these sites after the bituminous overlays have been constructed and determine the time and extent of reflective cracking.


MP 28.8
99 + 50
J
APD 537(79)
2.017 MILES
AWD. 12-2-74
KY. ROAD OILING &
EDWARDS & WEBB
M.P. 26.9
MP 26.8
206 + 00
I
APD 537(67)
1.712 MILES
AWD. 10-30-73
EDWARDS & WEBB
MP 25.1
296 + 50
M.P. 23.0
H
APD 537(65)
2.718 MILES
AWD. 7-26-73
WATTS & CALL CONST.
MP 22.4
440 + 00
G
APD 537(55)
2.082 MILES
AWD. 8-17-72
KY. ROAD OILING INC. &
WATTS & CALL
MP 20.3
550 + 00
F
APD 537(63)
2.605 MILES
AWD. 5-7-73
BIZZACK BROS. CONST. CORP.
MP 17.7
687 + 48.76 BK.
=580 + 73.93 AH.
E
APD 537(54)
5.116 MILES
AWD. 5-26-72
MP 14.7
700 + 00
THE MARBLE CLIFF QUARRIES CO.
D
MP 12.6
851 + 00
C
APD 537(53)
1.723 MILES
AWD. 5-26-72
WATTS & CALL &
RR DAWSON BRIDGE
M.P. 11.2
MP 10.7
942 + 00
B
APD 537(52)
3.002 MILES
AWD. 7-5-72
KY ROAD OILING
MP 7.7
1100 + 50
A
APD 537(56)
4.654 MILES
AWD. 7-26-73
KY ROAD OILING
MP 3.1
1346 + 74.81
MP 0.00
PAVE.
MED.
SHLDR.
13" DGA
6½" B.S.
5/8" SAS Tp. II
FD DGA
3" B.B.
1" B.S.
5" DGA
Slag Aggr. - DGA, B.B., B.S.
- SAS Tp II
12" DGA
6½" B.B.
1" B.S.
Ls. Aggr. - DGA
Slag Aggr. - B.B., B.S.
9½" DGA
5½" B.B.
1" B.S.
Ls. Aggr. - DGA
Slag Aggr. - B.B., B.S.
Ls. Aggr. - DGA, B.B., B.S.
12" DGA
Lw. Aggr. - DGA, B.B., B.S.
11" DGA
Slag Aggr. - B.B., B. S.
1085 + 00 G. D. S
1100 + 50 G. D
9" DGA
Slag Aggr. - DGA, B.B., B.S.
EAL = 40-80
EAL = 20-40
CBR=5
CBR=9
CBR=6
Const. Rev.
M.P. 20.24
N=1.8"
S=1.6"
M.P. 17.5
N=0.4"
S=1.4"
MP 14.7
MP 12.6
N=1.8"
S=2.2"
MP 11.2
MP 9.6
N=2.4"
S=2.7"
MP 3.1
OVERLAY
REQUIRED
12/84
(8 Yr. Des
(20 yr)
EAL
8.5x10^6
11/8/85
(20 yr)
EAL
7.6x10^6
11/8/85
M.P. 23.0
(20 yr)
EAL
5.3x10^6
11/8/85
20 Yr.
EAL
7.2x10^6
10/21/85
20 Yr.
EAL
8.9x10^6
10/21/85
OHIO
RIVER
GREENUP
SCIOTO
LAWRENCE
GREENBO LAKE STATE RESORT PARK

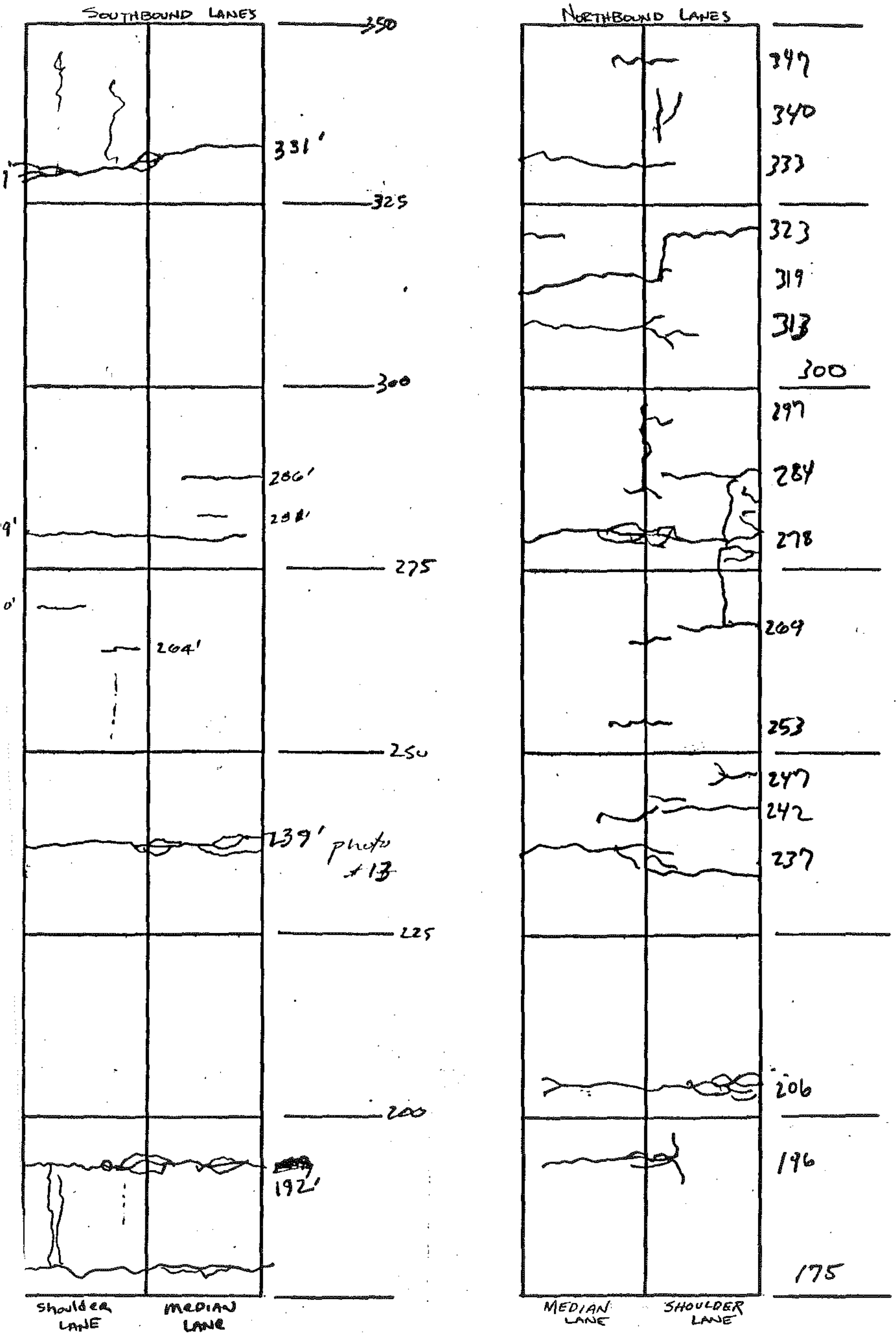
U.S. 23 DESIGN SECTION A

GREENUP COUNTY

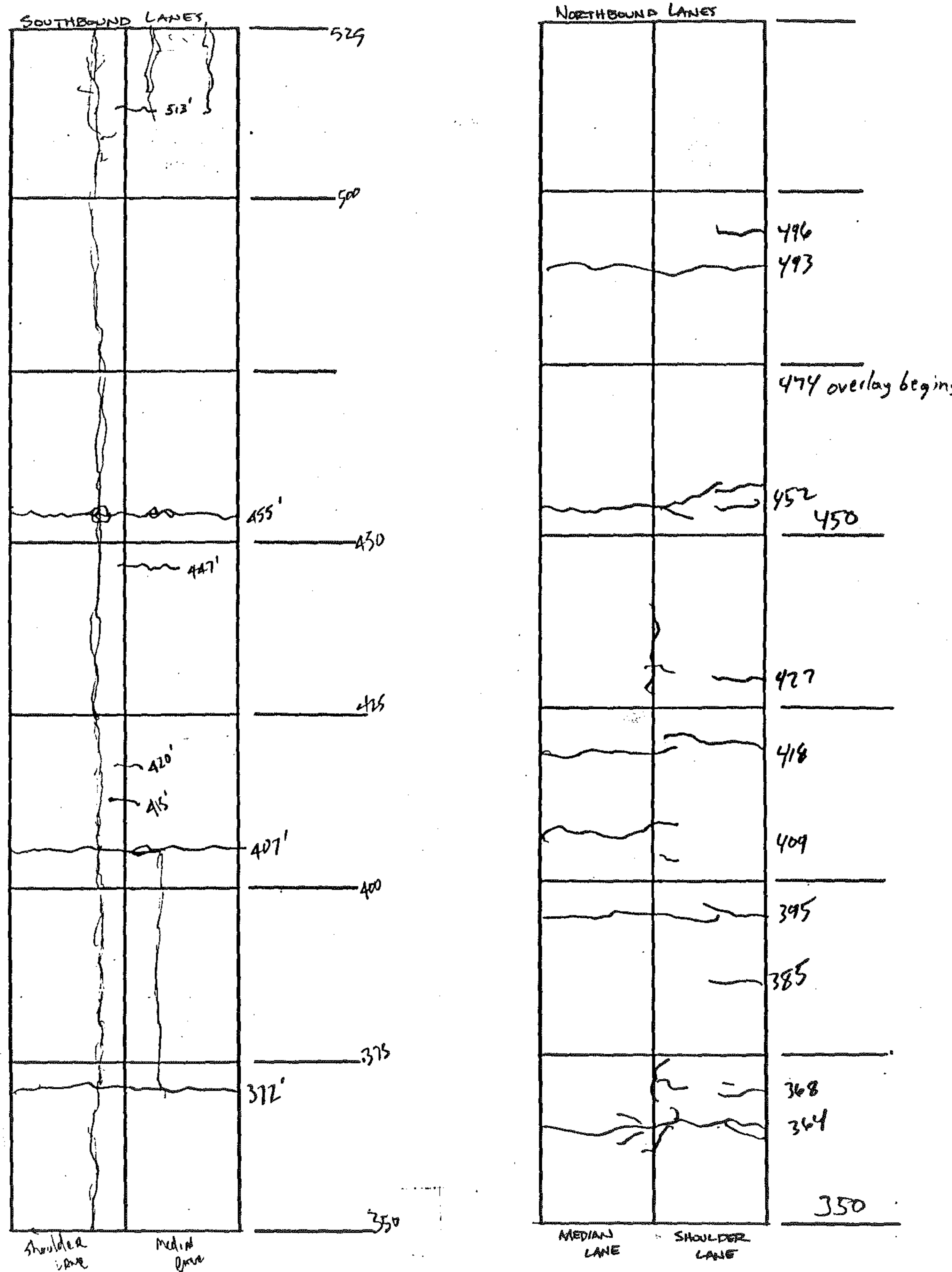


U.S. 23 DESIGN SECTION A

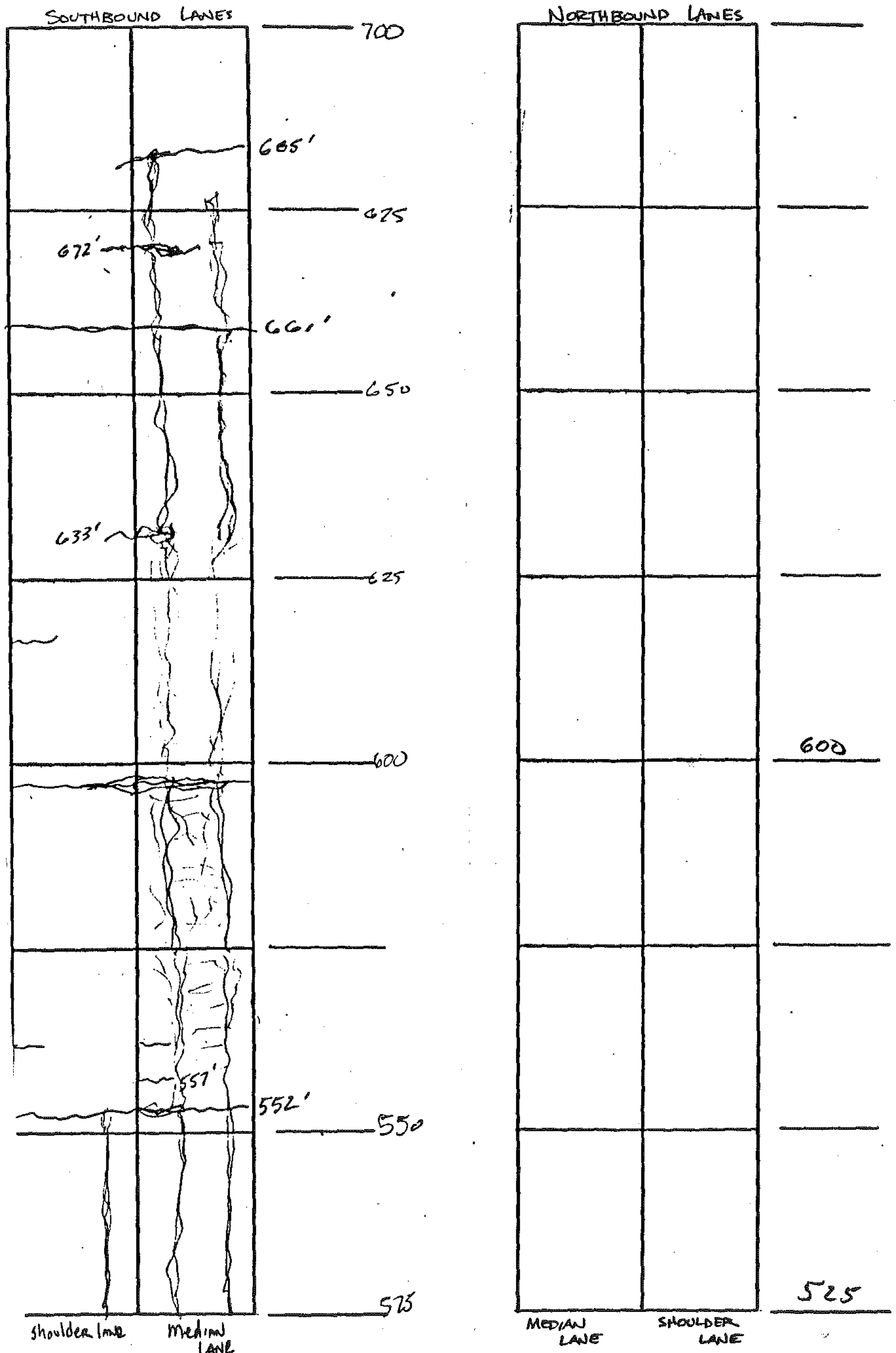
GREENUP COUNTY



U.S. 23 DESIGN SECTION A
GREENUP COUNTY

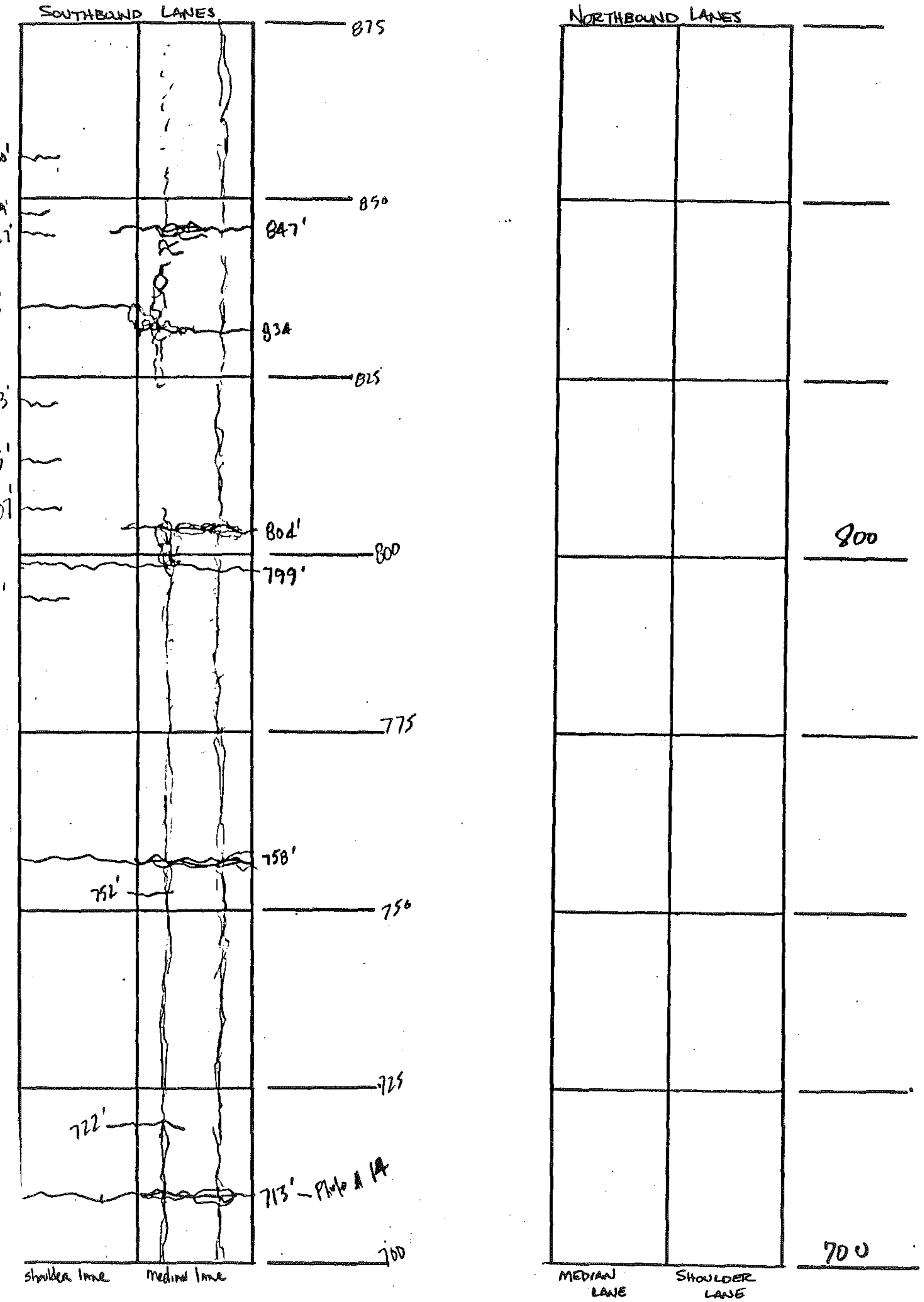


U.S. 23 DESIGN SECTION A
GREENUP COUNTY



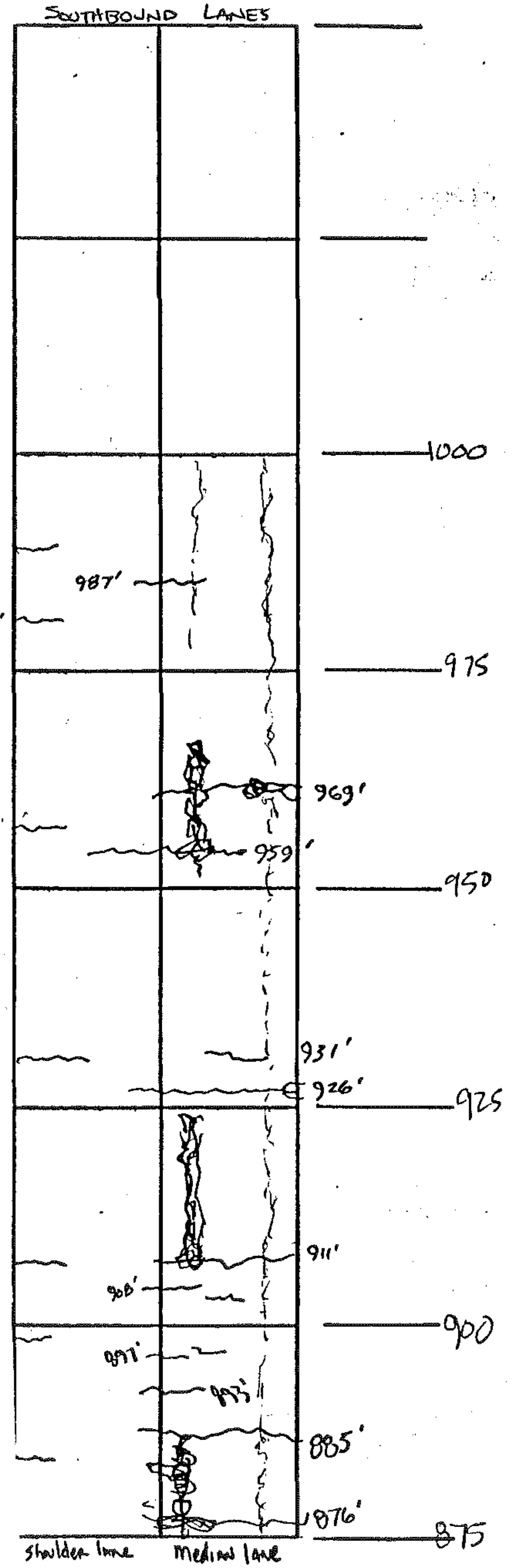
U.S. 23 Design Section A

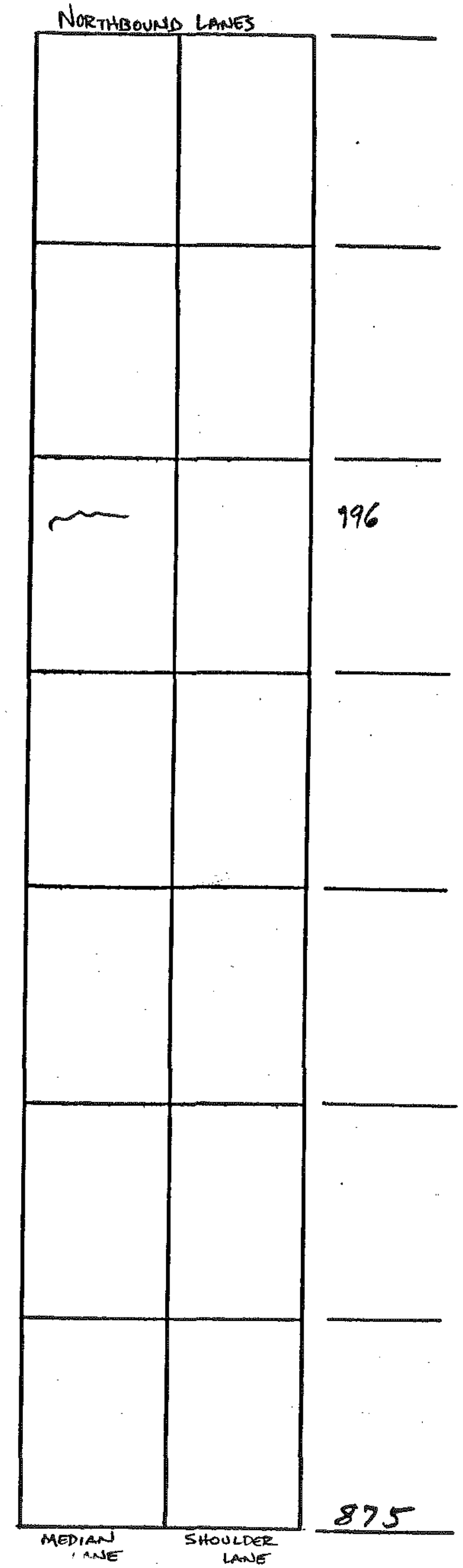
Greenup County

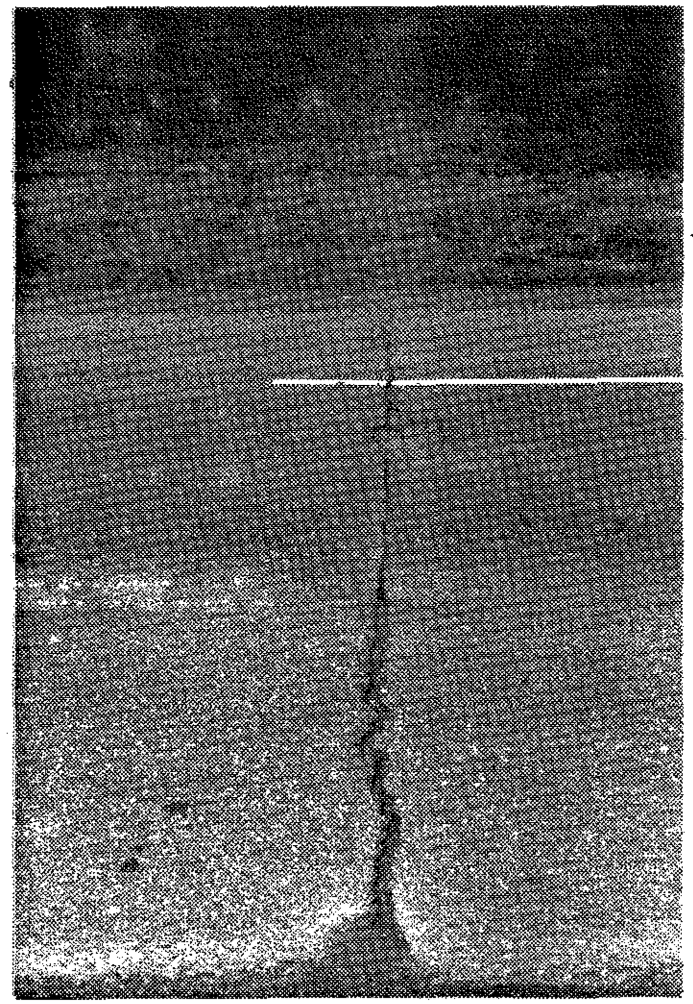


U.S. 23 DESIGN SECTION A

GREENUP COUNTY







Section A - SB lanes at 116 ft.

Section A - SB lanes at 239 ft.

U.S. 23 Greenup County 3/17 & 3/18/86

SECTION A Northbound MP. 7.0 to 7.0 + 1000 Ft

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
1			0+36	transverse	24'	
2			0+36	Alligator		7'
3			0+82	transverse	12'	
4			0+94	transverse	13'	
5			1+11	"	24'	
6			1+14	"	5'	
7			1+20	"	11'	
8			1+55	"	24'	
9			1+55	Alligator		10'
10			1+63	transverse	4'	
11			1+96	"	13'	
12			2+06	"	22'	
13			2+06	Alligator		14'
14			2+37	transverse	24'	
15			2+37	Alligator		8'
16			2+42	transverse	17'	
17			2+47	"	5'	
18			2+53	"	6'	
19			2+69	"	9'	
20	2+69	2+84		Longitudial	15'	
21			2+78	transverse	24'	
22			2+78	Alligator	7'	
23	2+75	2+84		Alligator	9'	
24			2+84	transverse	10'	

f2

SECTION A Northbound MP. 7.0 to 7.0 + 1000 Ft

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
25	2+81	2+97		Longitudial	16'	
26			2+97	transverse	2'	
27			3+13	"	16'	
28			3+19	"	13'	
29	3+19	3+23		Longitudial	4'	
30			3+23	transverse	10'@ 4'	
31			3+33	"	14'	
32	3+38	3+42		Longitudial	4'	
33			3+47	transverse	5'	
34			3+64	"	24'	
35			3+64	Alligator		10'
36			3+68	transverse	6'@ 4'	
37	3+65	3+73		Longitudial	8'	
38			3+85	transverse	7'	
39			3+95	"	24'	
40			4+09	"	14'	
41			4+18	"	24'	
42			4+27	"	6'	
43	4+27	4+38		Longitudial	11'	
44			4+52	transverse	24'	
	overlay begins		4+74			
45			4+93	transverse	24'	
46			4+96	"	5'	
47			9+96	"	5'	

End Section A

SECTION A - US23SB MP. 7.0 to 7.0 - 1000 FT to NORTH
GREENUP COUNTY

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)	
1	0+00	1+86		ALIGATOR CRACKING		1392	
2			0+07	TRANSVERSE CRACKING	6'		
3			0+20	TRANSVERSE Cracking	6'		
4			0+29	TRANSVERSE CRACKING	15		
5			0+57	TRANSVERSE Cracking	2		
6			0+67	TRANSVERSE CRACKING	34' *		
7	0+67	1+16		LONGITUDINAL CRACK	49		
8			0+88	TRANSVERSE CRACK	3		
9			1+04	TRANSVERSE Crack	10		
10			1+16	TRANSVERSE Crack	34 *		
11			1+16	ALIGATOR Cracking		3	
12	1+47	1+62		LONGITUDINAL CRACK	15		
13			1+50	TRANSVERSE Crack	24		
14			1+53	TRANSVERSE Crack	8		
15			1+64	TRANSVERSE Crack	4'		
16			1+79	TRANSVERSE Crack	24'		
17	1+79	1+92		ALIGATOR ~~LONGITUDINAL~~ Cracking	[illegible]'	32	
18			1+92	TRANSVERSE CRACK	24		
19			1+92	ALIGATOR CRACKING		10	
20			2+39	TRANSVERSE Crack	24		Photo
21			2+39	ALIGATOR cracking		12	Photo
22			2+64	TRANSVERSE Cracking	5		
23			2+70	TRANSVERSE Cracking	6		
24			2+79	TRANSVERSE Cracking	22		

* ACROSS TURN LANE ALSO

SECTION A MP. 7.0 to 7.0 - 1000 FT TO NORTH

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
25			2+81	TRANSVERSE CRACKING	2	
26			2+86	TRANSVERSE CRACKING	9	
27	3+27	3+31		TRANSVERSE CRACK	24	
28	3+27	3+45		LONGITUDINAL CRACKING	18	
29			3+29	ALIGATOR CRACKING		5
30	3+50	5+52		ALIGATOR CRACKING		505
31			3+72	TRANSVERSE CRACKING	24	
32	3+72	4+07		LONGITUDINAL CRACKING	35	
33			4+07	TRANSVERSE CRACKING	24'	
34			4+07	ALIGATOR CRACKING		2
35			4+15	TRANSVERSE CRACKING	4'	
36			4+20	TRANSVERSE CRACKING	4	
37			4+47	TRANSVERSE CRACKING	7	
38			4+55	TRANSVERSE CRACKING	24	
39			4+55	ALIGATOR CRACKING		3
40			5+13	TRANSVERSE CRACKING	4	
41	5+13	6+85		ALIGATOR CRACKING		860
42			5+52	TRANSVERSE CRACKING	24	
43			5+57	TRANSVERSE CRACKING	4	
44			5+61	TRANSVERSE CRACKING	4	
45			5+92	TRANSVERSE CRACKING	24	
46			5+92	ALIGATOR CRACKING		7
47			6+18	TRANSVERSE CRACKING	5	
48			6+33	TRANSVERSE CRACKING	4	

SECTION A MP. 7.0 to 7.0 - 1000 FT To North

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)	
49			6+61	Transverse Cracking	24		
50			6+72	Transverse Cracking	11		
51			6+85	Transverse Cracking	13		
52	7+00	8+00		Aligator Cracking		500	
53			7+13	Transverse Cracking	24'		Photo
54			7+13	Aligator Cracking		10	
55			7+22	Transverse Cracking	8		
56			7+52	Transverse Cracking	4		
57			7+58	Transverse Cracking	24'		
58			7+58	Aligator Cracking		12	
59			7+89	Transverse Cracking	6		
60			7+99	Transverse Cracking	24		
61			8+04	Transverse Cracking	14		
62			8+04	Aligator Cracking		9	
63			8+07	Transverse Cracking	5		
64			8+15	Transverse Cracking	5		
65			8+23	Transverse Cracking	5		
66	8+04	8+25		Aligator Cracking		53	
67			8+35	Transverse Cracking	24		
68	8+34	10+00		Aligator Cracking		830	
69			8+47	Transverse Cracking	14 ~~#6~~		
70			8+47	Aligator Cracking		5	
71			8+47	Transverse Cracking	4		
72			8+49	Transverse Cracking	4		

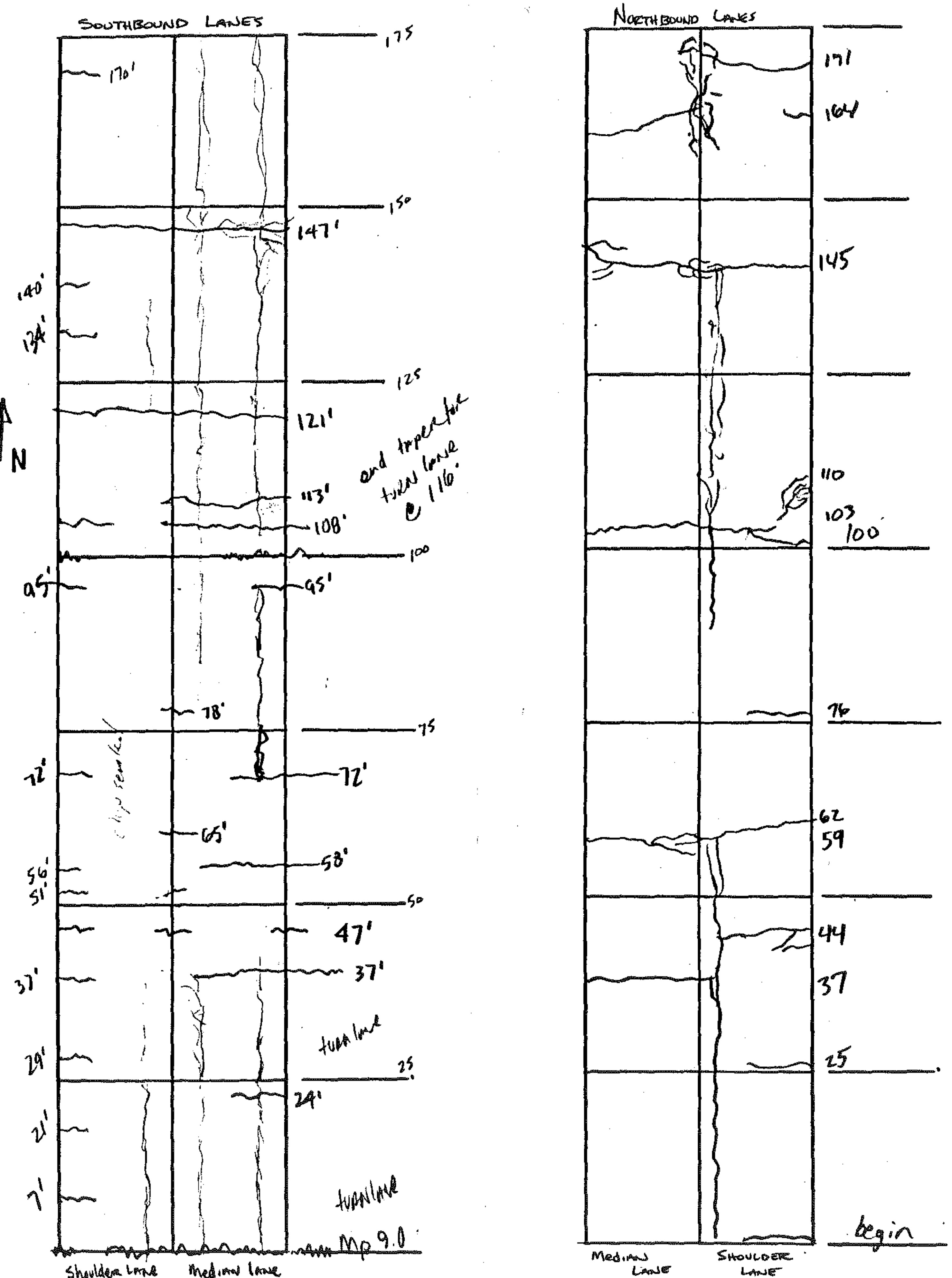
SECTION A MP. 7.0 to 7.0 - 1000 FT TO NORTH

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
73			8+60	Transverse Cracking	4	
74			8+76	Transverse Cracking	12	
75			8+82	Transverse Cracking	4	
76			8+85	Transverse Cracking	14	
77			8+93	Transverse Cracking	5	
78			8+97	Transverse Cracking	6	
79			8+99	Transverse Cracking	3	
80			9+08	Transverse Cracking	7	
81			9+11	Transverse Cracking	14	
82			9+26	Transverse Cracking	14	
83			9+31	Transverse Cracking	10	
84			9+59	Transverse Cracking	14	
85			9+61	Transverse Cracking	4	
86			9+69	Transverse Cracking	13	
87			9+82	Transverse Cracking	4	
88			9+87	Transverse Cracking	6	
89			9+89	Transverse Cracking	4	

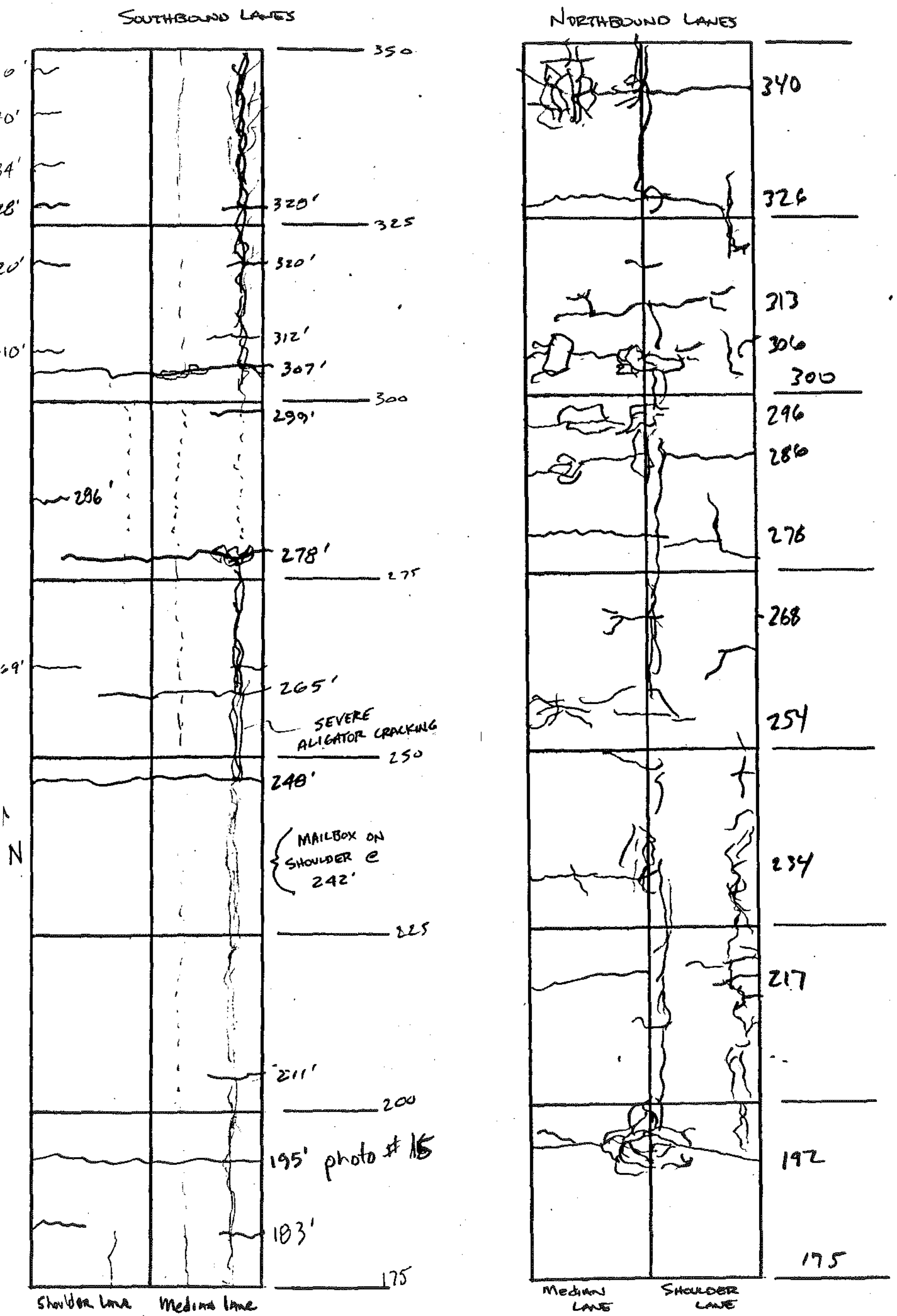
APPENDIX B

U.S. 23 GREENUP COUNTY

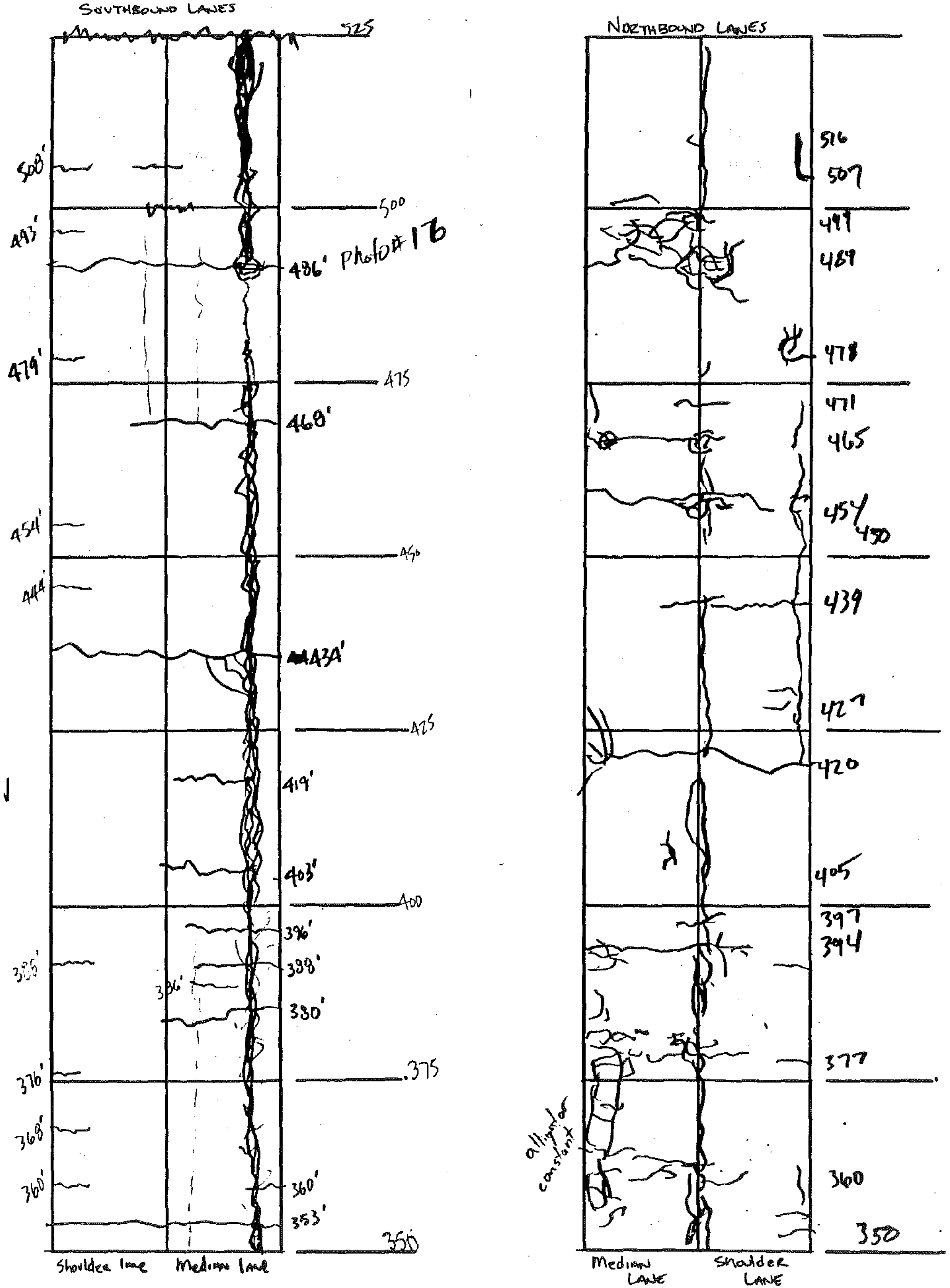
DESIGN SECTION B



U.S. 23 GREENUP COUNTY
DESIGN SECTION B

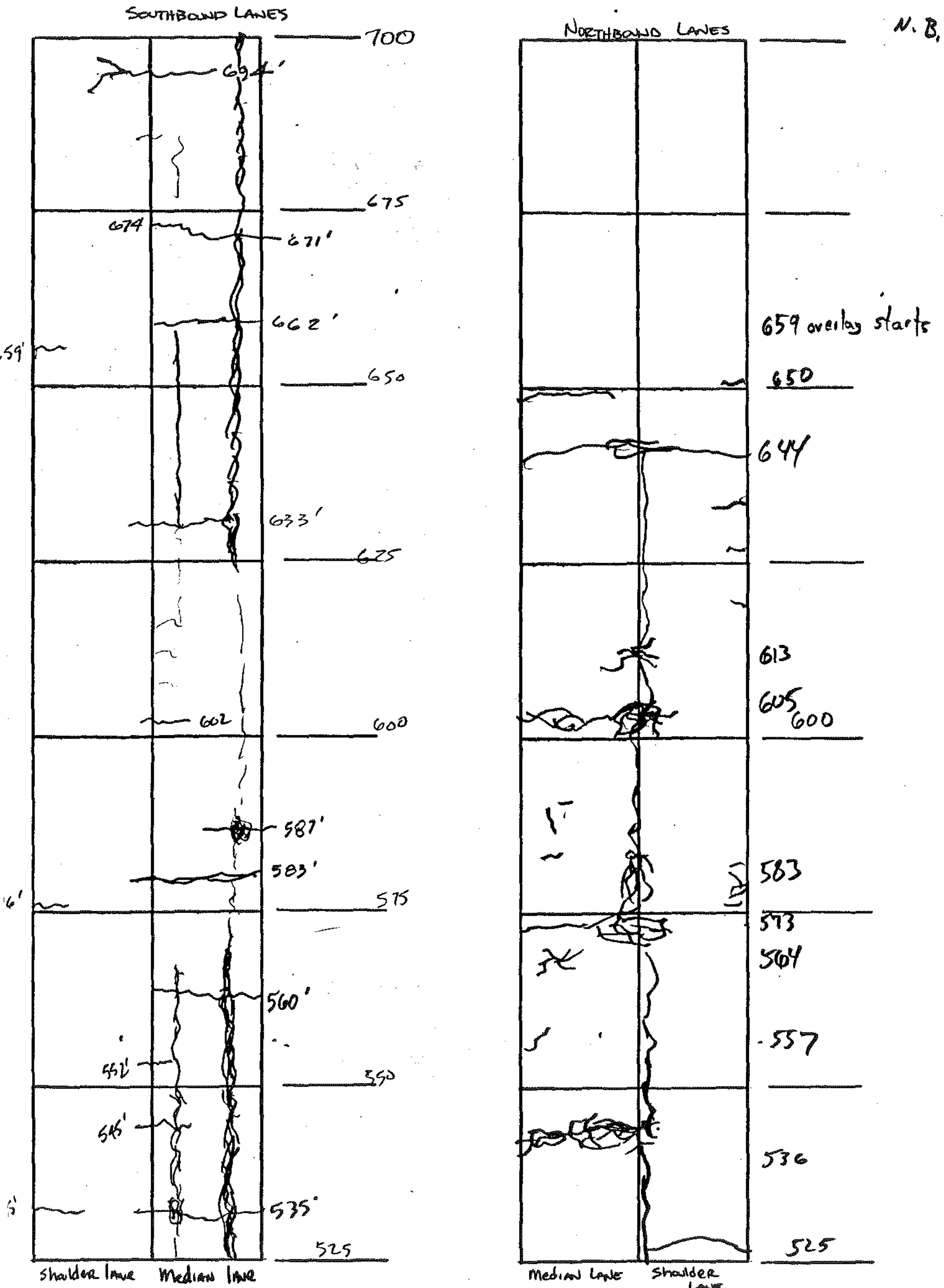


U.S. 23 GREENUP COUNTY
DESIGN SECTION B
SOUTHBOUND LANES

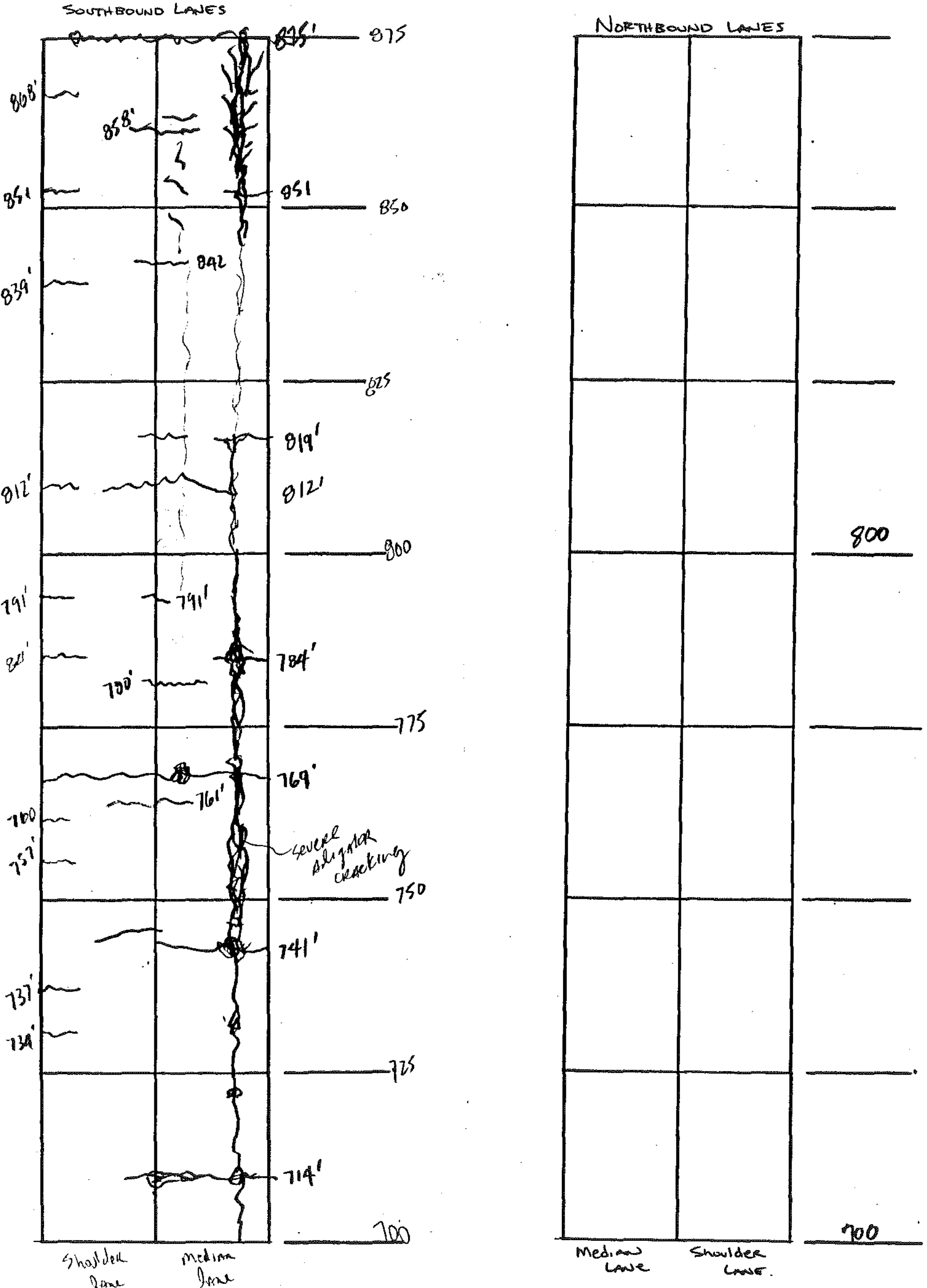


U.S. 23 GREENUP COUNTY
DESIGN SECTION B

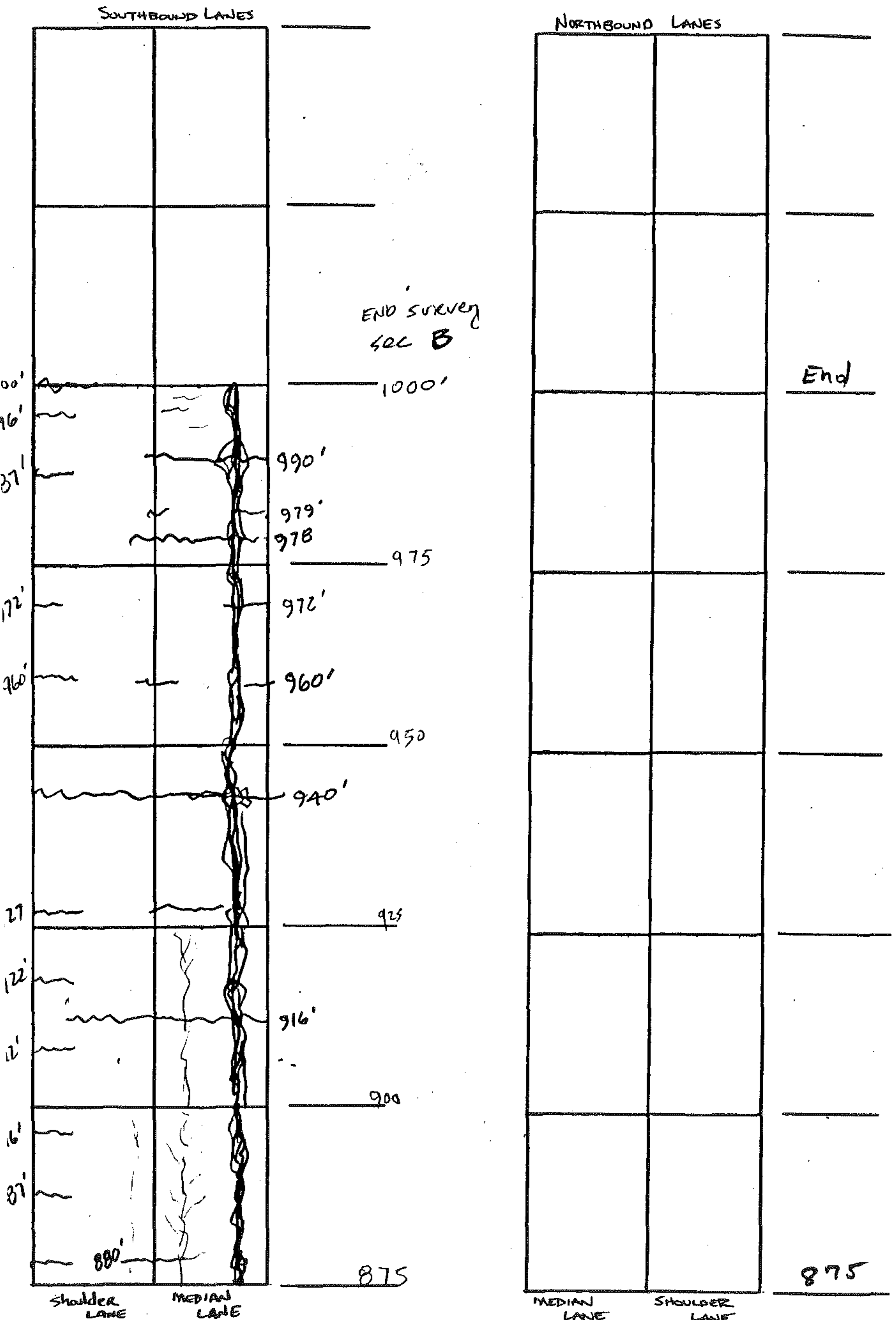
Sec. B m.p. 9.0
N.B.



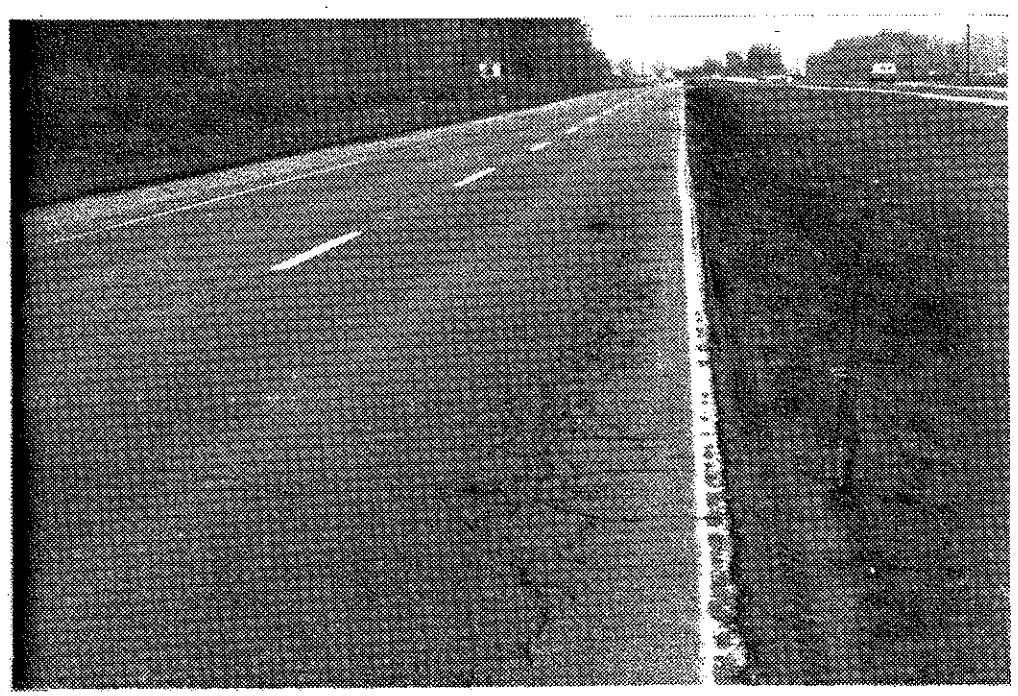
U.S. 23 Greenup County
Design Section B
Southbound Lanes



U.S. 23 GREENUP COUNTY
DESIGN SECTION B



Section B - SB lanes at 195 ft.



Section B - SB lanes at 486 ft.

SECTION B Northbound MP. 9.0 to 9.0 + 1000 ft.

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
1			0+00	transverse	8'	
2	0+00	0+62		Longitudial	62'	
3			0+25	transverse	6'	
4			0+37	"	13'	
5			0+44	"	10'	
6			0+44	Alligator		4'
7			0+62	transverse	24'	
8			0+76	"	6'	
9	0+81	1+45		Longitudial	64'	
10			1+00	transverse	24'	
11	1+03	1+10		Alligator		14'
12			1+45	transverse	24'	
13			1+45	Alligator		4'
14	1+59	1+75		"		32'
15			1+64	transverse	2'@ 12'	
16			1+71	"	12'	
17'			1+92	"	24'	
18			1+92	Alligator		40'
19	2+00	2+34		Longitudial	34'	
20	2+00	2+50		Alligator		150'
21			2+17	transverse	12'	
22			2+34	"	12'	
23			2+34	Alligator		6'
24			2+54	"		26'

SECTION B Northbound MP. 9.0 to 9.0 + 1000 ft

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
25	2+54	3+13		Longitudial	59'	
26			2+68	transverse	4'	
27			2+78	"	24'	
28			2+86	"	24'	
29			2+86	Alligator		6'
30	2+86	3+00		"		42'
31			2+96	Alligator		8'
32			3+06	transverse	14'	
33			3+06	Alligator		40'
34	3+06	3+13		Longitudial	7'	
35			3+13	transverse	13'	
36	3+19	3+30		Longitudial	11'	
37			3+26	transverse	20'	
38	3+26	4+39		Longitudial	113'	
39			3+40	transverse	15'	
40	3+36	3+50		Alligator		56'
41			3+50	transverse	2'	
42	3+55	3+94		Alligator		76'
43			3+77	transverse	2'@ 8'	
44			3+94	"	15'	
45			4+20	"	24'	
46	4+20	4+71		Longitudial	51'	
47			4+39	transverse	14'	
48			4+54	"	18'	

SECTION B Northbound MP. 9.0 to 9.0 +1000 ft.

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
49			4+54	Alligator		9'
50	4+65	4+71		Longitudial	6'	
51			4+65	transverse	13'	
52			4+65	Alligator		6'
53			4+71	transverse	5'	
54			4+78	"	4'	
55	4+89	4+99		Alligator		120'
56			5+00	transverse	6'	
57	5+00	6+44		Longitudial	144'	
58	5+07	5+16		"	9'	
59			5+25	transverse	12'	
60			5+36	Alligator		24'
61			5+57	Longitudial	2'	
62			5+64	Alligator		4'
63	5+70	5+83		Alligator		39'
64			5+73	transverse	12'	
65			5+83	transverse	2'	
66			6+13	tranverse	4'	
67			6+44	transverse	24'	
68			6+50	"	10'	
	Overlay starts		6+59			
				End		

SECTION B - US23 SB
GREENUP COUNTY

MP. 9.0 to 9.0 - 1000 FT. to NORTH

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
1			0+00	TRANSVERSE CRACK	26*	
2			0+07	TRANSVERSE CRACK	4	
3	0+00	0+37		ALIGATOR CRACKING		278
4			0+21	TRANSVERSE CRACK	3	
5			0+24	TRANSVERSE CRACK	6	
6			0+29	TRANSVERSE CRACK	3	
7			0+37	TRANSVERSE CRACK	19	
8			0+47	TRANSVERSE CRACKING	9	
9			0+51	TRANSVERSE CRACKING	3	
10			0+56	TRANSVERSE CRACKING	2	
11			0+58	TRANSVERSE CRACKING	13	
12			0+65	TRANSVERSE CRACKING	4	
13			0+72	TRANSVERSE CRACKING	16	
14	0+72	0+95		ALIGATOR CRACKING		58
15			0+78	TRANSVERSE CRACKING	3	
16			0+95	TRANSVERSE CRACKING	9	
17			1+00	TRANSVERSE CRACKING	12	
18			1+08	TRANSVERSE CRACKING	20	
19			1+13	TRANSVERSE CRACKING	13	
20			1+21	TRANSVERSE CRACKING	24	
21	1+00	10+00		ALIGATOR CRACKING		2250
22a	1+00	4+00		ALIGATOR CRACKING		750
22b	4+68	4+86		ALIGATOR CRACKING		45
22c	5+25	5+65		ALIGATOR CRACKING		100

* ACROSS TURN LANE ALSO

SECTION B- US23SB MP. 9.0 to 9.0 + 1000 FT To North
GREENUP COUNTY

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
21d	6+15	6+62		ALIGATOR CRACKING		118
21e	7+91	8+58		ALIGATOR CRACKING		168
21f	8+75	9+25		ALIGATOR CRACKING		125
22			1+34	TRANSVERSE CRACKING	4	
23			1+40	TRANSVERSE CRACKING	3	
24			1+47	TRANSVERSE CRACKING	24	
25			1+47	ALIGATOR CRACKING		8
26			1+70	TRANSVERSE CRACKING	4	
27			1+83	TRANSVERSE CRACKING	10	
28			1+95	TRANSVERSE CRACKING	24	
29			2+11	TRANSVERSE CRACKING	6	
30			2+48	TRANSVERSE CRACKING	24	
31			2+65	TRANSVERSE CRACKING		
32			2+69	TRANSVERSE CRACKING	8	
33			2+78	TRANSVERSE CRACKING	21	
34			2+78	ALIGATOR CRACKING		4
35			2+86	TRANSVERSE CRACKING	3	
36			2+99	TRANSVERSE CRACKING	6	
37			3+07	TRANSVERSE CRACKING	24	
38			3+07	ALIGATOR CRACKING		6
39			3+10	TRANSVERSE CRACKING	3	
40			3+12	TRANSVERSE CRACKING	5	
41			3+20	TRANSVERSE CRACKING	6	
42			3+28	TRANSVERSE CRACKING	6	

SECTION B- US23 SB GREENUP COUNTY MP. 9.0 to 9.0 - 1000 FT to NORTH

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
43			3+34	TRANSVERSE CRACKING	4	
44			3+40	TRANSVERSE CRACKING	4	
45			3+46	TRANSVERSE CRACKING	4	
46			3+53	TRANSVERSE CRACKING	24	
47			3+60	TRANSVERSE CRACKING	8	
48			3+68	TRANSVERSE CRACKING	4	
49			3+76	TRANSVERSE CRACKING	3	
50			3+80	TRANSVERSE CRACKING	12	
51			3+86	TRANSVERSE CRACKING	5	
52			3+88	TRANSVERSE CRACKING	13	
53			3+96	TRANSVERSE CRACKING	10	
54			4+03	TRANSVERSE CRACKING	10	
55			4+19	TRANSVERSE CRACKING	9	
56			4+34	TRANSVERSE CRACKING	24	
57			4+44	TRANSVERSE CRACKING	4	
58			4+54	TRANSVERSE CRACKING	3	
59			4+68	TRANSVERSE CRACKING	15	
60			4+79	TRANSVERSE CRACKING	3	
61			4+86	TRANSVERSE CRACKING	24	
62			4+86	ALLIGATOR CRACKING		3
63			4+93	TRANSVERSE CRACKING	3	
64			5+00	TRANSVERSE CRACKING	4	
65			5+08	TRANSVERSE CRACKING	6	
66			5+25	TRANSVERSE CRACKING	24	

SECTION B-U.S.23 SB   MP. 9.0 to 1000 FT TO NORTH
Greenup County

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
67			5+35	Transverse Cracking	19	
68			5+45	Transverse Cracking	6	
69			5+52	Transverse Cracking	4	
70			5+60	Transverse Cracking	12	
71			5+76	Transverse Cracking	3	
72			5+83	Transverse Cracking	14	
73			5+87	Transverse Cracking	7	
74			6+02	Transverse Cracking	5	
75			6+08	Transverse Cracking	2	
76			6+14	Transverse Cracking	2	
77			6+20	Transverse Cracking	2	
78			6+33	Transverse Cracking	12	
79			6+59	Transverse Cracking	3	
80			6+62	Transverse Cracking	12	
81	6+71	6+74		Transverse Cracking	12	
82	6+76	6+86		Longitudinal Cracking	10	
83			6+94	Transverse Cracking	14	
84			7+14	Transverse Cracking	14	
85			7+14	Aligator Cracking		6
86			7+34	Transverse Cracking	3	
87			7+37	Transverse Cracking	4	
88			7+41	Transverse Cracking	12	
89			7+43	Transverse Cracking	7	
90			7+57	Transverse Cracking	3	

SECTION B - U.S. 23 SB MP. 9.0 to 9.0 - 1000 FT TO NORTH
Greenup County

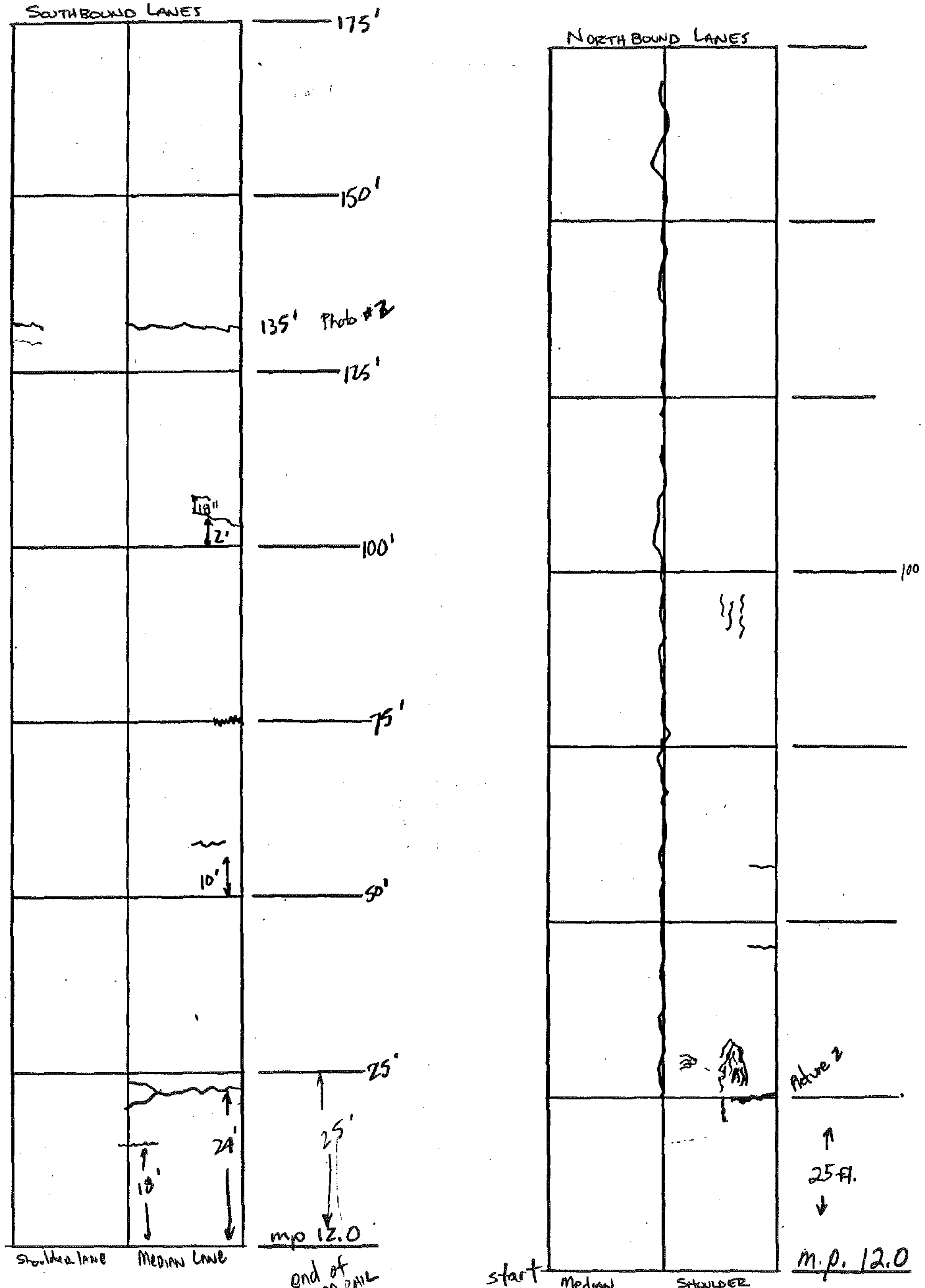
DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
91			7+61	TRANSVERSE CRACKING	13	
92			7+69	TRANSVERSE CRACKING	24	
93			7+80	TRANSVERSE CRACKING	7	
94			7+84	TRANSVERSE CRACKING	12	
95			7+91	TRANSVERSE CRACKING	6	
96			8+12	TRANSVERSE CRACKING	16	
97			8+19	TRANSVERSE CRACKING	12	
98			8+39	TRANSVERSE CRACK	5	
99			8+42	TRANSVERSE CRACK	6	
100			8+51	TRANSVERSE CRACK	8	
101			8+58	TRANSVERSE CRACK	6	
102			8+68	TRANSVERSE CRACK	3	
103			8+75	TRANSVERSE CRACK	22	
104			8+80	TRANSVERSE CRACK	12	
105			8+87	TRANSVERSE CRACK	4	
106			8+96	TRANSVERSE CRACK	4	
107			9+12	TRANSVERSE CRACK	4	
108			9+16	TRANSVERSE CRACK	20	
109			9+22	TRANSVERSE CRACK	4	
110			9+27	TRANSVERSE CRACK	14	
111			9+40	TRANSVERSE CRACK	24	
112			9+60	TRANSVERSE CRACK	9	
113			9+72	TRANSVERSE CRACK	6	
114			9+78	TRANSVERSE CRACK	14	

SECTION B.-US23 SB MP. 9.0 to 9.0 - 1000 FT to NORTH
GREENUP COUNTY

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
115			9+79	TRANSVERSE CRACK	5	
116			9+87	TRANSVERSE CRACK	4	
117			9+90	TRANSVERSE CRACK	13	
118			9+96	TRANSVERSE CRACK	4	
119			10+00	TRANSVERSE CRACK	6	

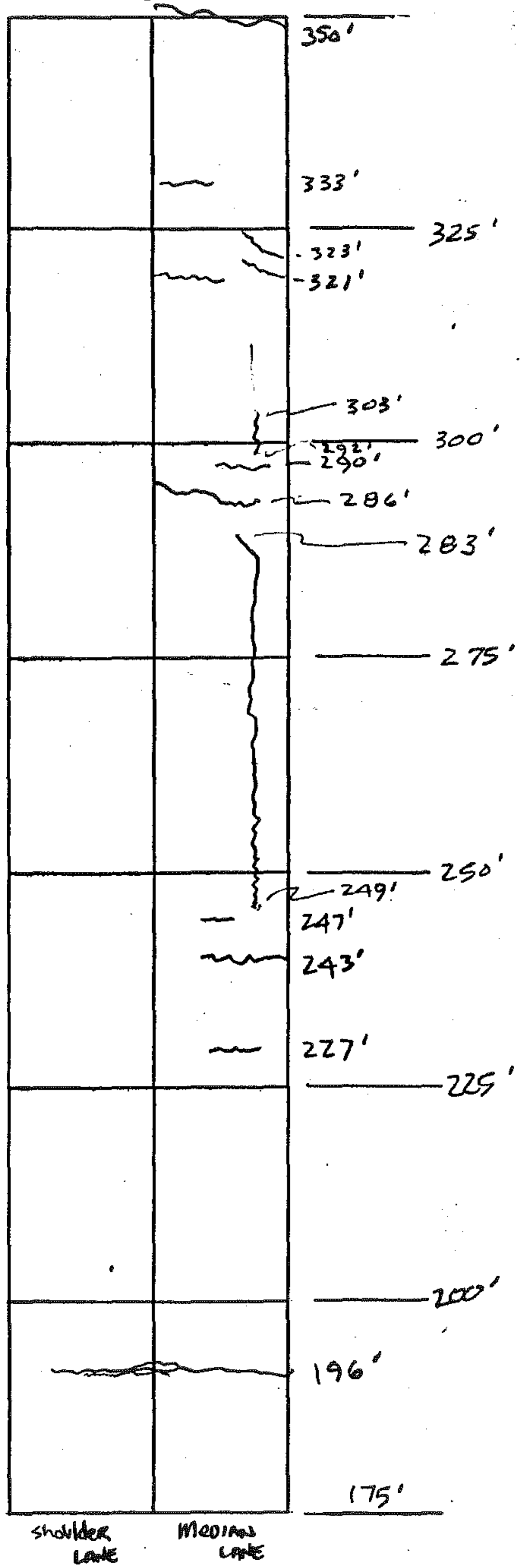
APPENDIX C

U.S. 23 GREENUP COUNTY
DESIGN SECTION C



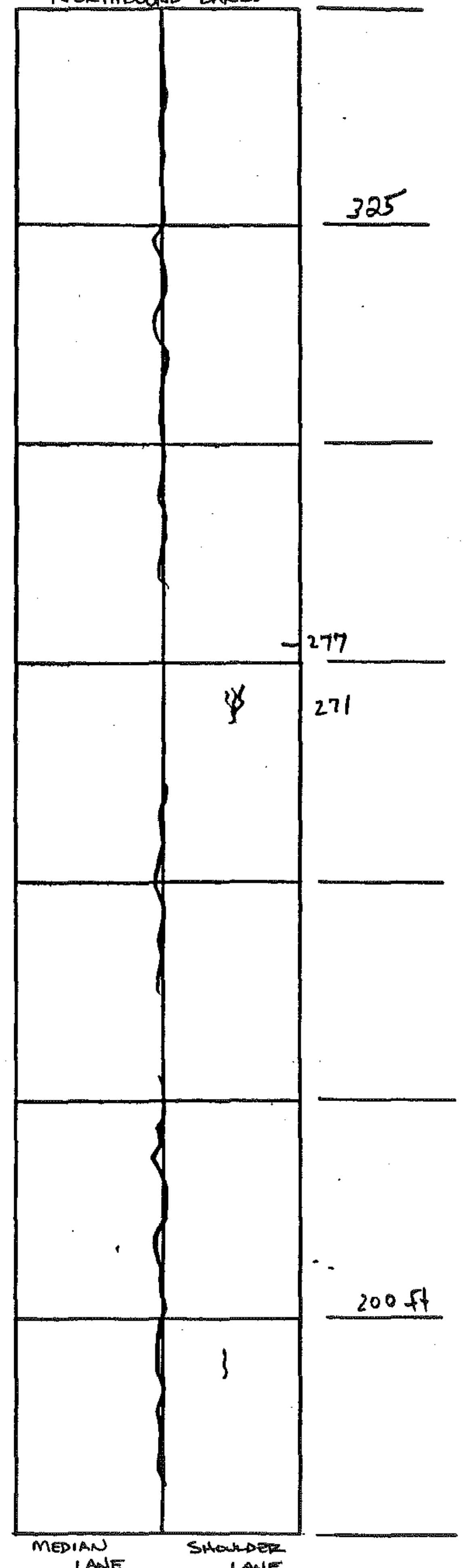
U.S. 23 Greenup County
Design Section C
Southbound Lanes

N



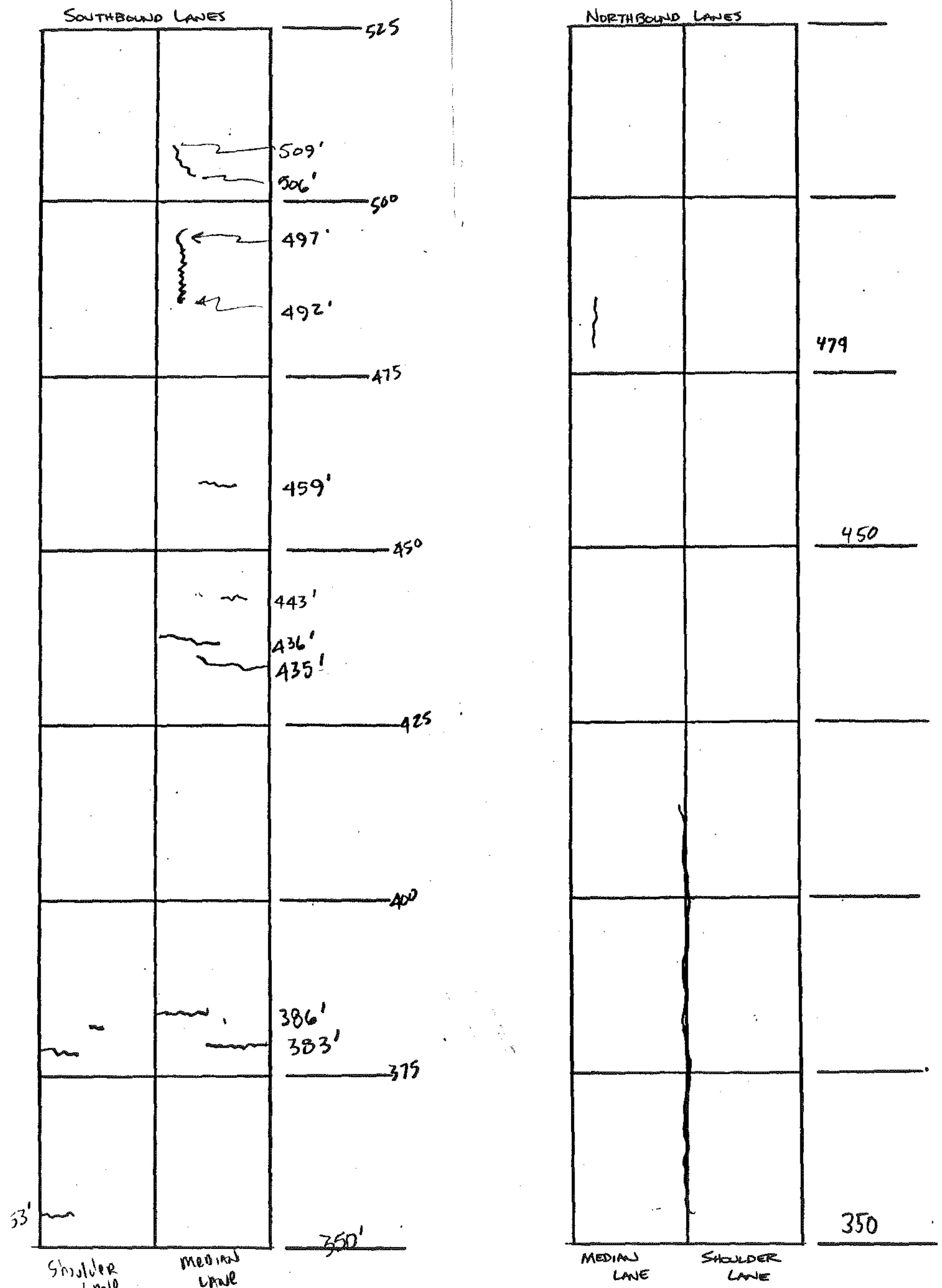
ft.

Northbound Lanes

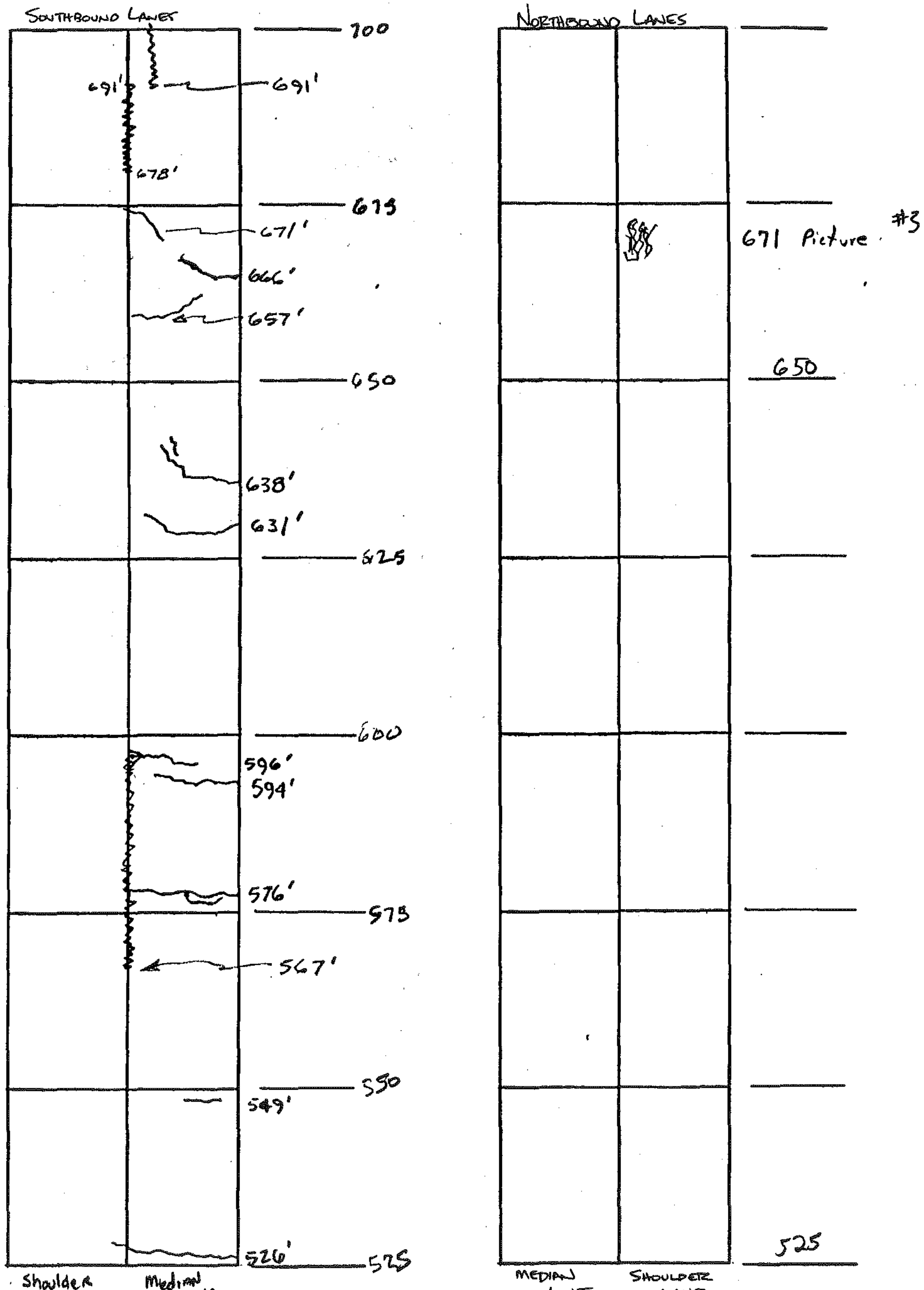


U.S. 23 Greenup County

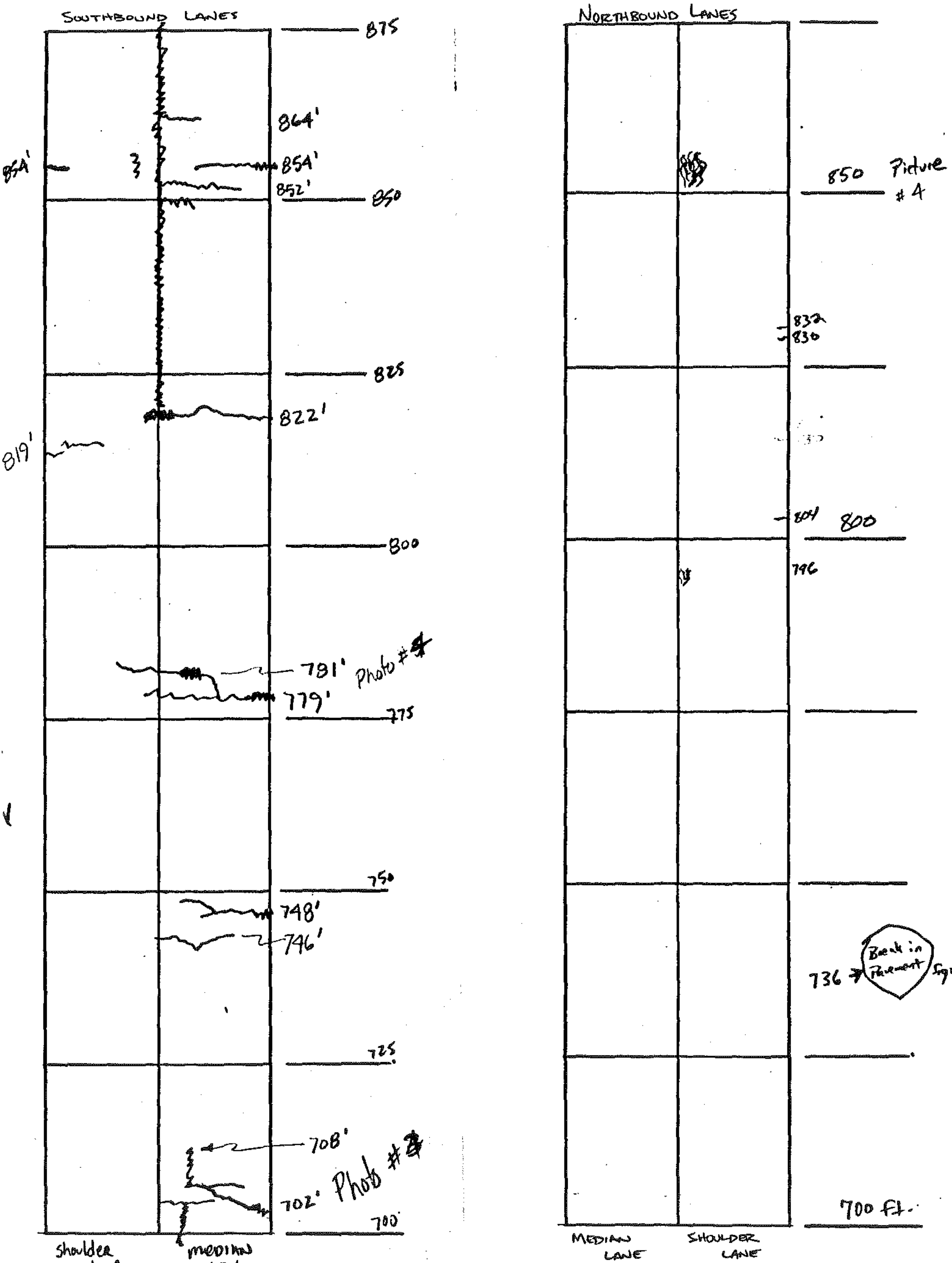
Design Section C



U.S. 23 Greenup County
Design Section C

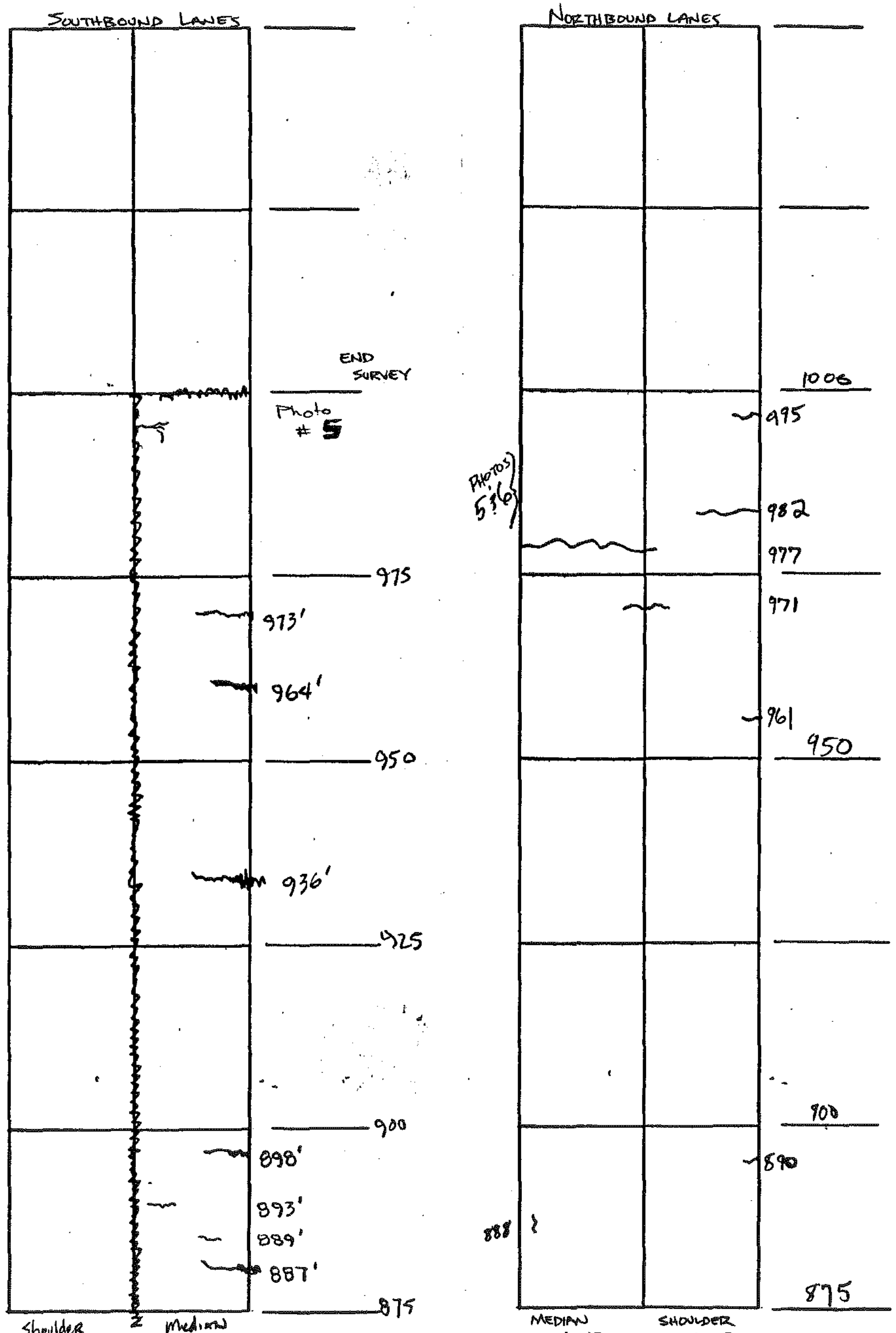


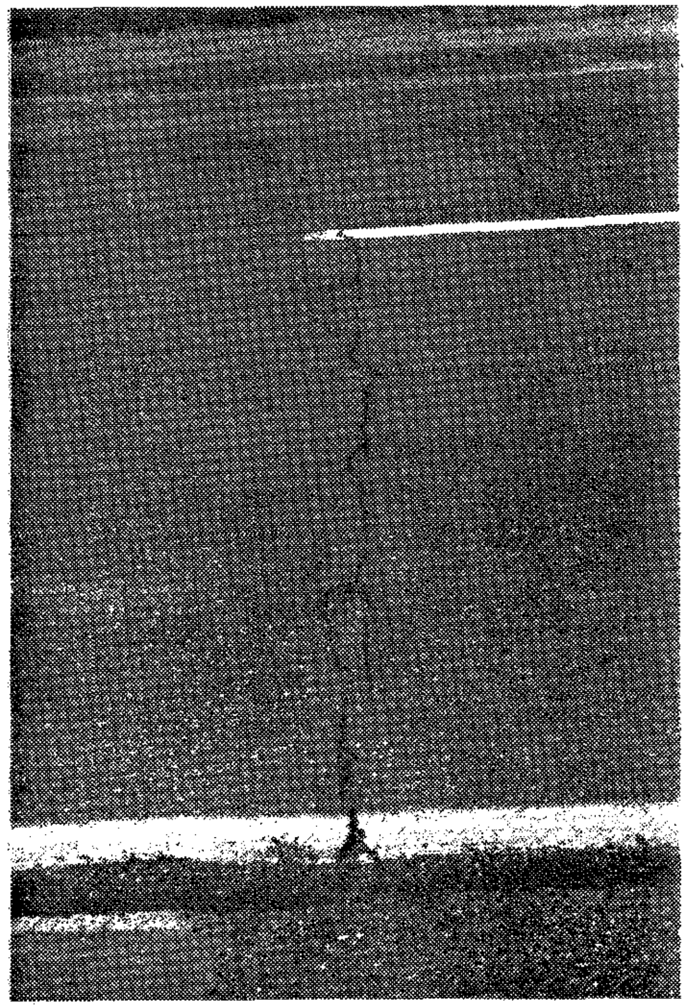
U.S. 23 GREENUP COUNTY
DESIGN SECTION C



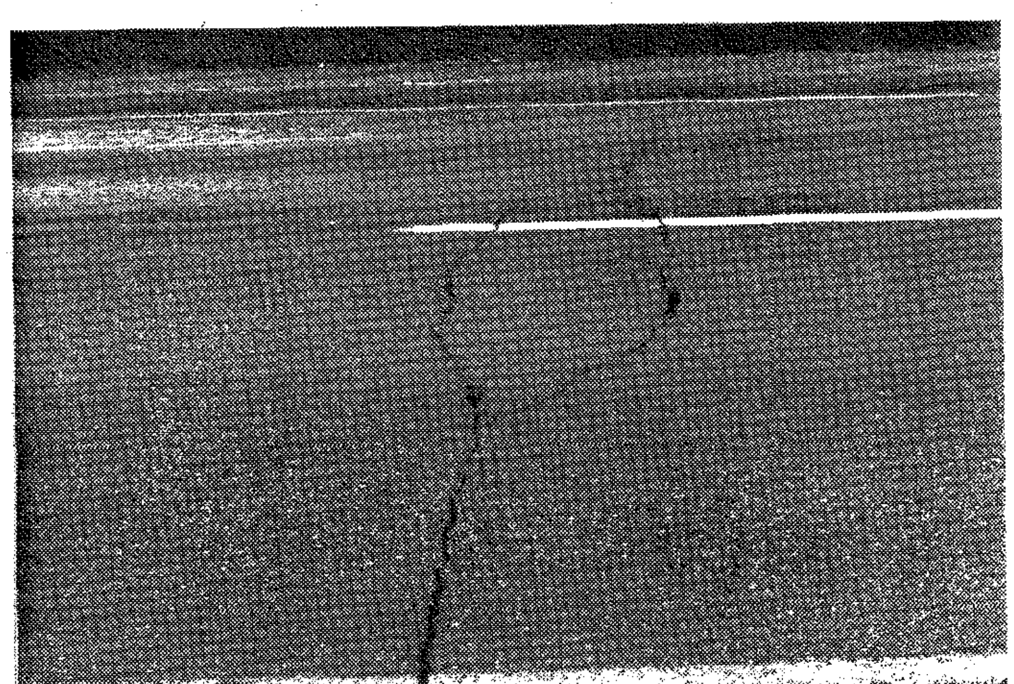
U.S. 23 GREENUP COUNTY

DESIGN SECTION C

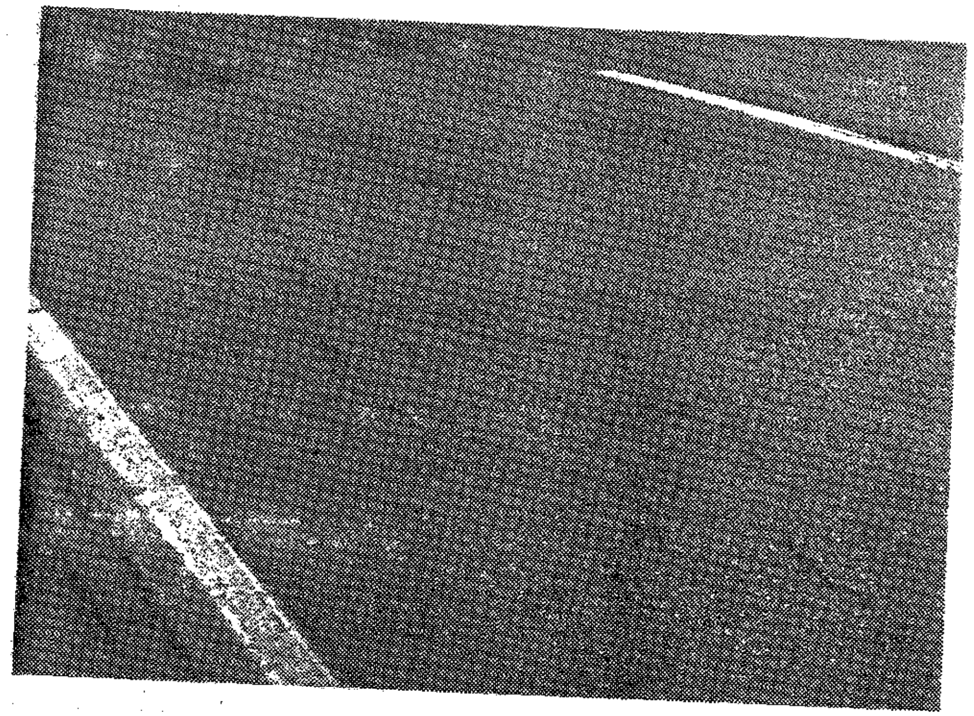




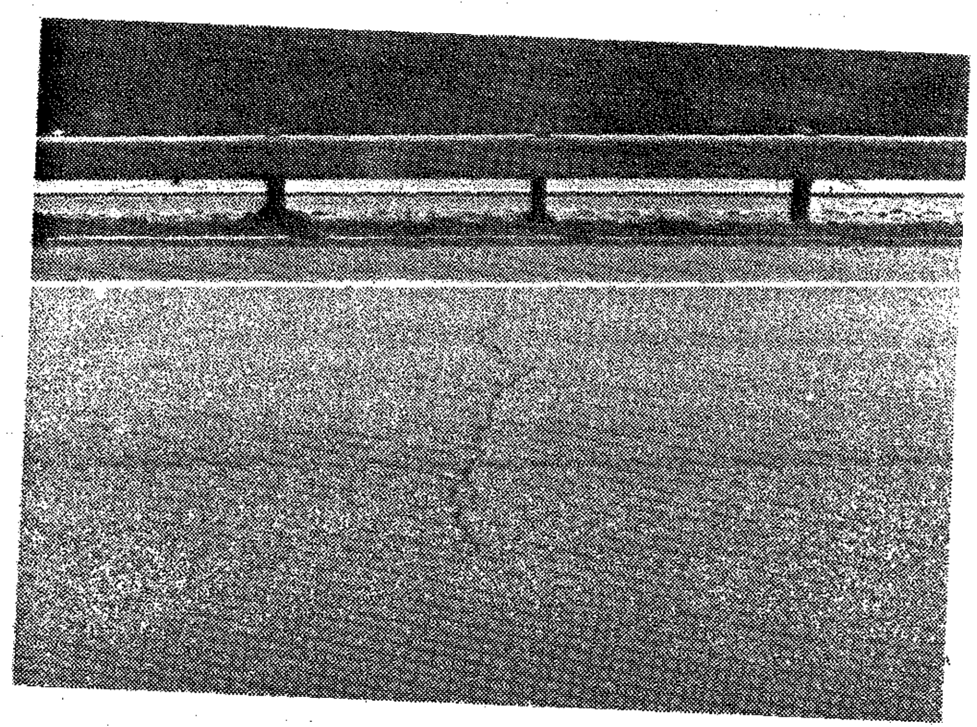
Section C - SB lanes at 135 ft.



Section C - SB lanes at 779 ft.



Section C - NB lanes at 26 ft.



Section C - NB lanes at 977 ft.

of 1

SECTION C Northbound MP. 12.0 to 12.0 + 1000 ft.

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
1	0+25	4+15		center line crack longitudial	390'	
2			0+25	transverse	5'	
3	0+26	0+35		Alligator		9'
4'			0+46	transverse	2'	
5			0+60	"	2'	
6	0+90	0+97		Longitudial	7'	
7			2+71	"	2'	
8			2+77	transverse	1'	
9	4+79	4+85		longitudial	6'	
10			6+71	Alligator		6'
11			7+96	"		4'
12			8+04	transverse	1'	
13			8+30	"	2'	
14			8+32	"	2'	
15			8+50	Alligator		6'
16			8+88	longitudial	1'	
17			8+90	transverse		
18			9+61	"	2'	
19			9+71	"	4'	
20			9+77	"	13'	
21			9+82	"	7'	
22			9+95	"	3'	
				End		

SECTION C. US23 SB MP. 12.0 to 12.0 - 1000 FT to NORTH = mp ~~12.2~~ 12.19
Greenup Co

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
1			0+18	TRANSVERSE CRACK	3	
2			0+24	TRANSVERSE CRACK	12	
3			0+60	TRANSVERSE CRACK	3	
4			0+75	TRANSVERSE CRACK	3	
5			1+02	TRANSVERSE CRACK	6	
6			1+04	TRANSVERSE CRACK	2	
7			1+35	TRANSVERSE CRACK	15	
8			1+96	TRANSVERSE CRACK	20	
9			1+96	ALIGATOR CRACKING		8
10			2+27	TRANSVERSE CRACK	3	
11			2+43	TRANSVERSE CRACK	8	
12			2+47	TRANSVERSE CRACK	2	
13	2+49	2+83		LONGITUDINAL CRACK	34	
14			2+86	TRANSVERSE CRACK	10	
15			2+90	TRANSVERSE CRACK	4	
16	2+92	3+03		LONGITUDINAL CRACK	11	
17			3+21	TRANSVERSE CRACK	7	
18	3+21	3+22		RANDOM TRANSVERSE	4	
19	3+23	3+25		RANDOM TRANSVERSE	4	
20			3+33	TRANSVERSE CRACK	5	
21			3+50	TRANSVERSE CRACK	12	
22			3+53	TRANSVERSE CRACK	4	
23			3+83	TRANSVERSE CRACK	10	
24			3+86	TRANSVERSE CRACK	6	

SECTION C US23SB MP. 12.0 to 12.0 - 1000 FT to North
Greenup County

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
25			4+35	Transverse Crack	8	
26			4+36	Transverse Crack	6	
27			4+43	Transverse Crack	2	
28			4+59	Transverse Crack	3	
29	4+92	4+97		Longitudinal Crack	5	
30	5+06	5+09		Random Transverse	3	
31			5+26	Transverse Crack	14	
32			5+49	Transverse Crack	3	
33	5+67	5+96		Longitudinal Crack	29	
34			5+76	Transverse Crack	12	
35			5+76	Aligator Cracking		3
36			5+94	Transverse Crack	9	
37			5+96	Transverse Crack	8	
38			6+31	Transverse Crack	11	
39	6+38	6+42		Random Transverse	10	
40	6+57	6+61		Random Transverse	9	
41	6+66	6+69		Random Transverse	7	
42	6+71	6+75		Random Transverse	4	
43	6+78	6+91		Longitudinal Crack	13	
44	6+91	7+02		Longitudinal Crack	11	
45			7+02	Transverse Crack	6	
46	7+02	7+08		Random Transverse	12	
47			7+46	Transverse Crack	8	
48			7+48	Random Transverse	10	

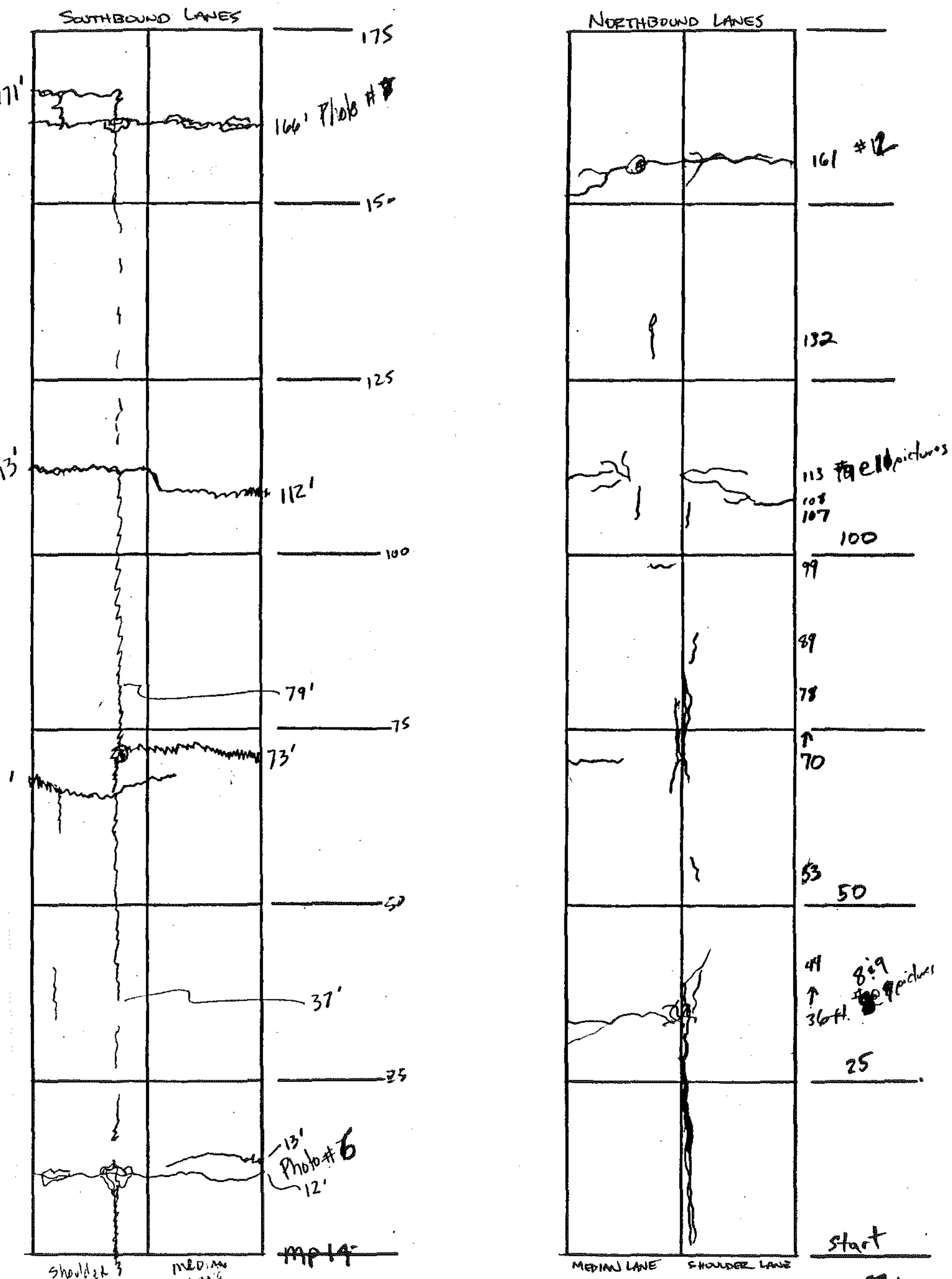
SECTION C - US23SB MP. 12 to 12 - 1000 FT TO NORTH

Greenup County

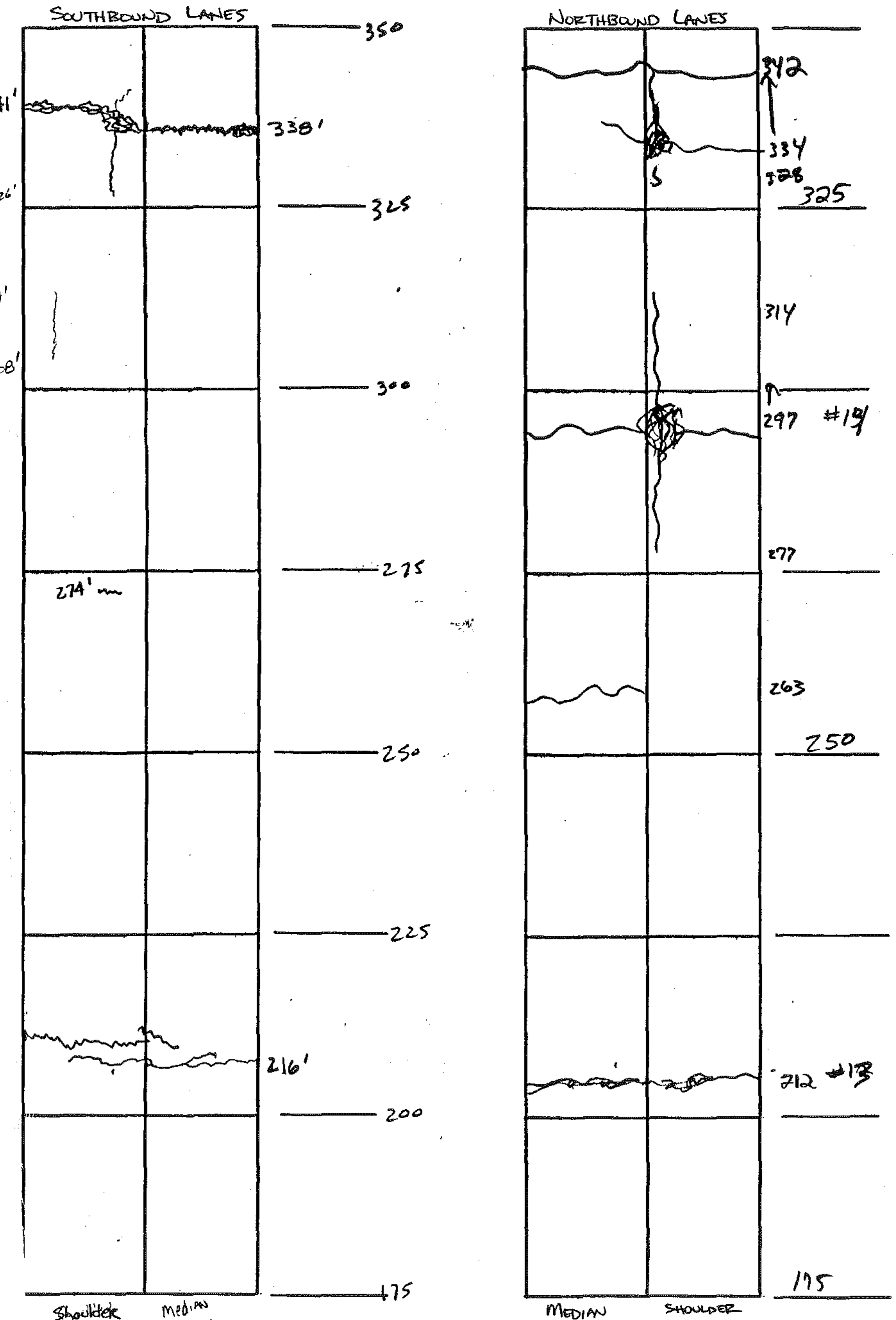
DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
49			7+79	TRANSVERSE / ALIGATOR	13	2
50			7+81	TRANSVERSE / ALIGATOR	10	2
51			8+19	TRANSVERSE CRACK	6	
52			8+22	TRANSVERSE / ALIGATOR	13	3
53	8+22	10+00		LONGITUDINAL CRACK	178	
54			8+50	TRANSVERSE CRACK	5	
55			8+52	TRANSVERSE CRACK	9	
56			8+54	TRANSVERSE CRACK	12	
57	8+53	8+56		LONGITUDINAL CRACK	3	
58			8+64	TRANSVERSE CRACK	4	
59			8+87	TRANSVERSE / ALIGATOR	5	2
60			8+89	TRANSVERSE CRACK	2	
61			8+93	TRANSVERSE CRACK	2	
62			8+98	TRANSVERSE / ALIGATOR	4	1
63			9+36	TRANSVERSE / ALIGATOR	6	2
64			9+64	TRANSVERSE CRACK	4	
65			9+73	TRANSVERSE CRACK	5	
66			9+93	RANDOM TRANSVERSE	2	
67			10+00	TRANSVERSE CRACK	12	

APPENDIX D

U.S. 23 GREENUP COUNTY
DESIGN SECTION D

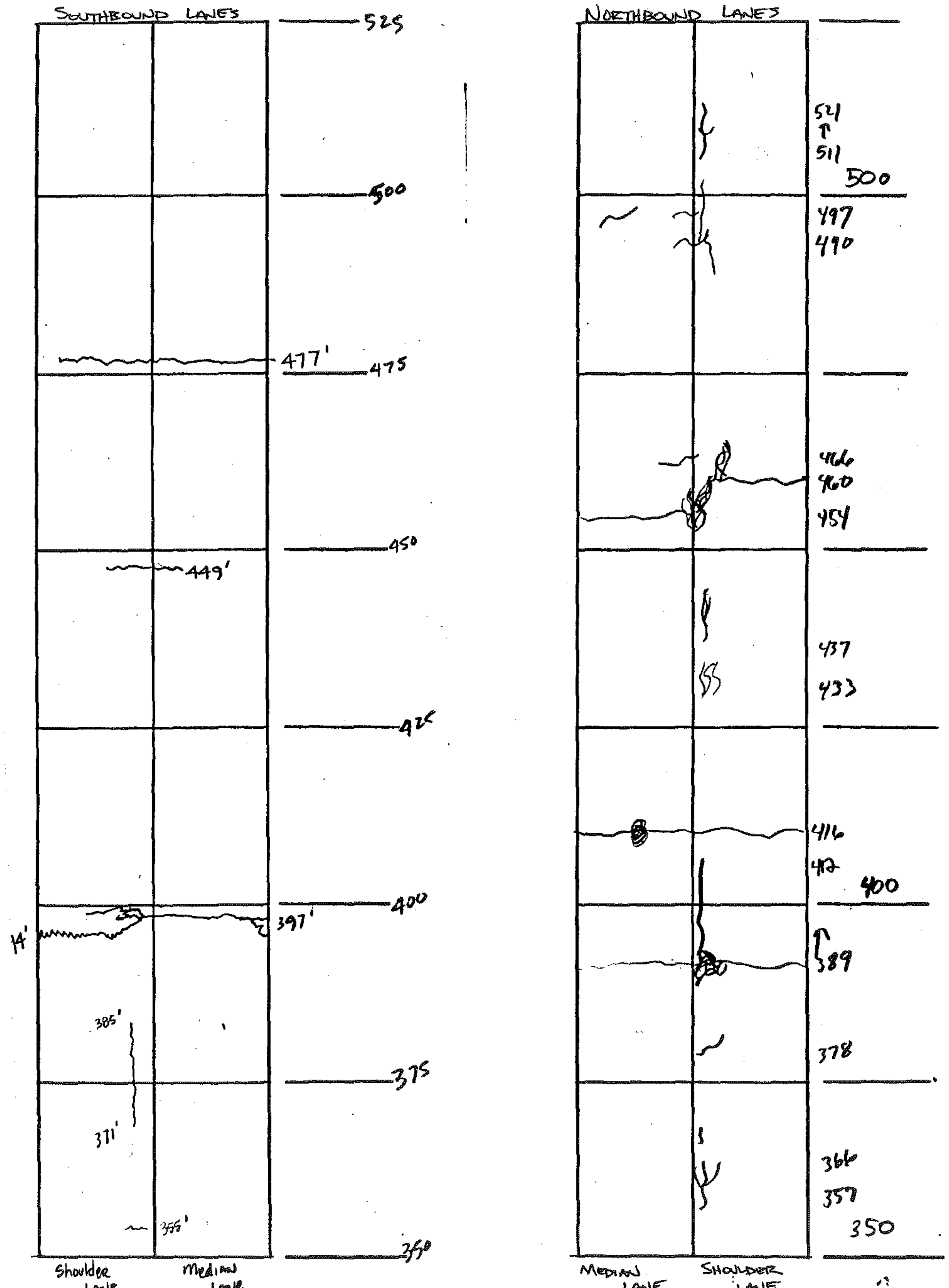


U.S. 23 Greenup County
Design Section D

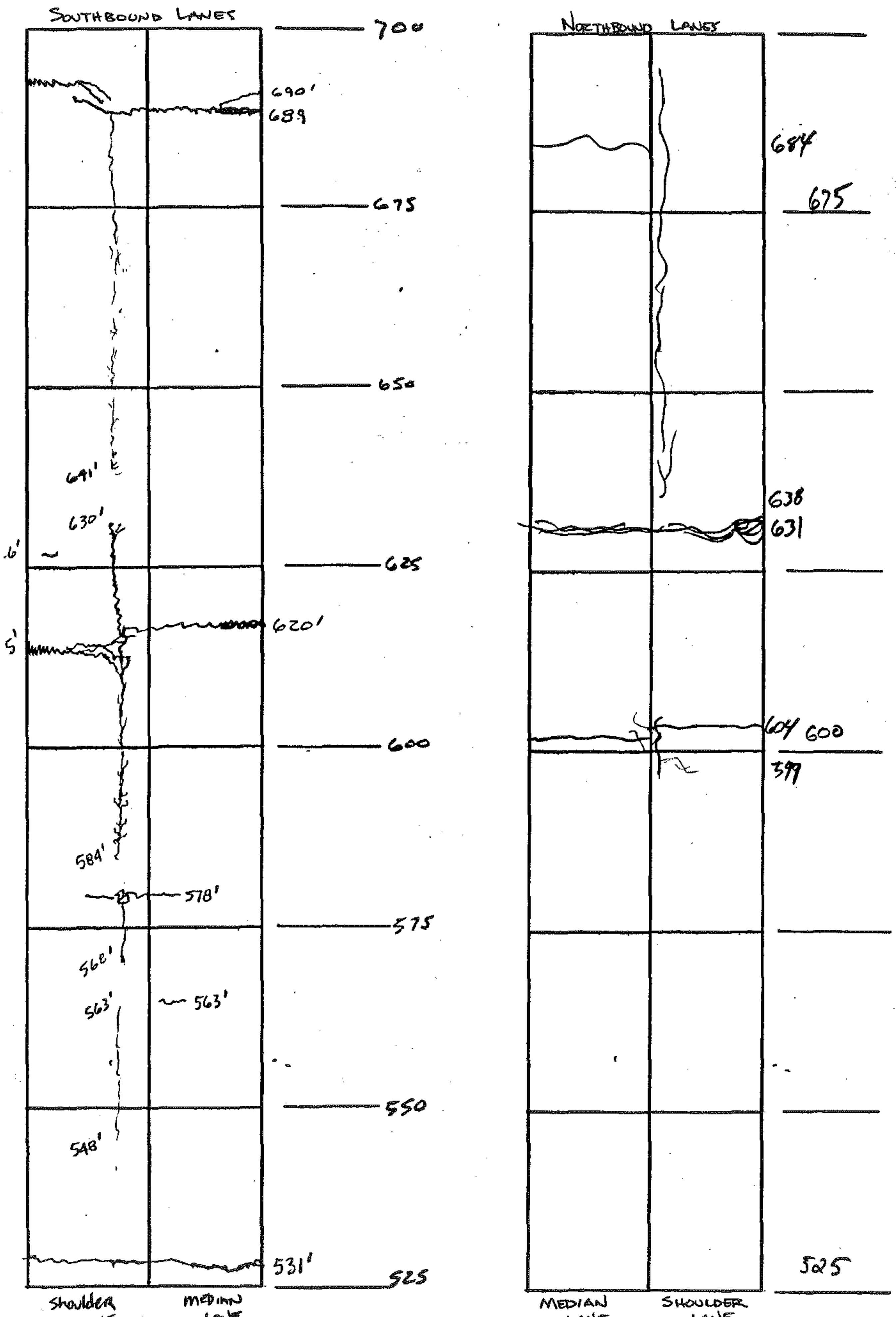


U.S. 23 GREENUP COUNTY

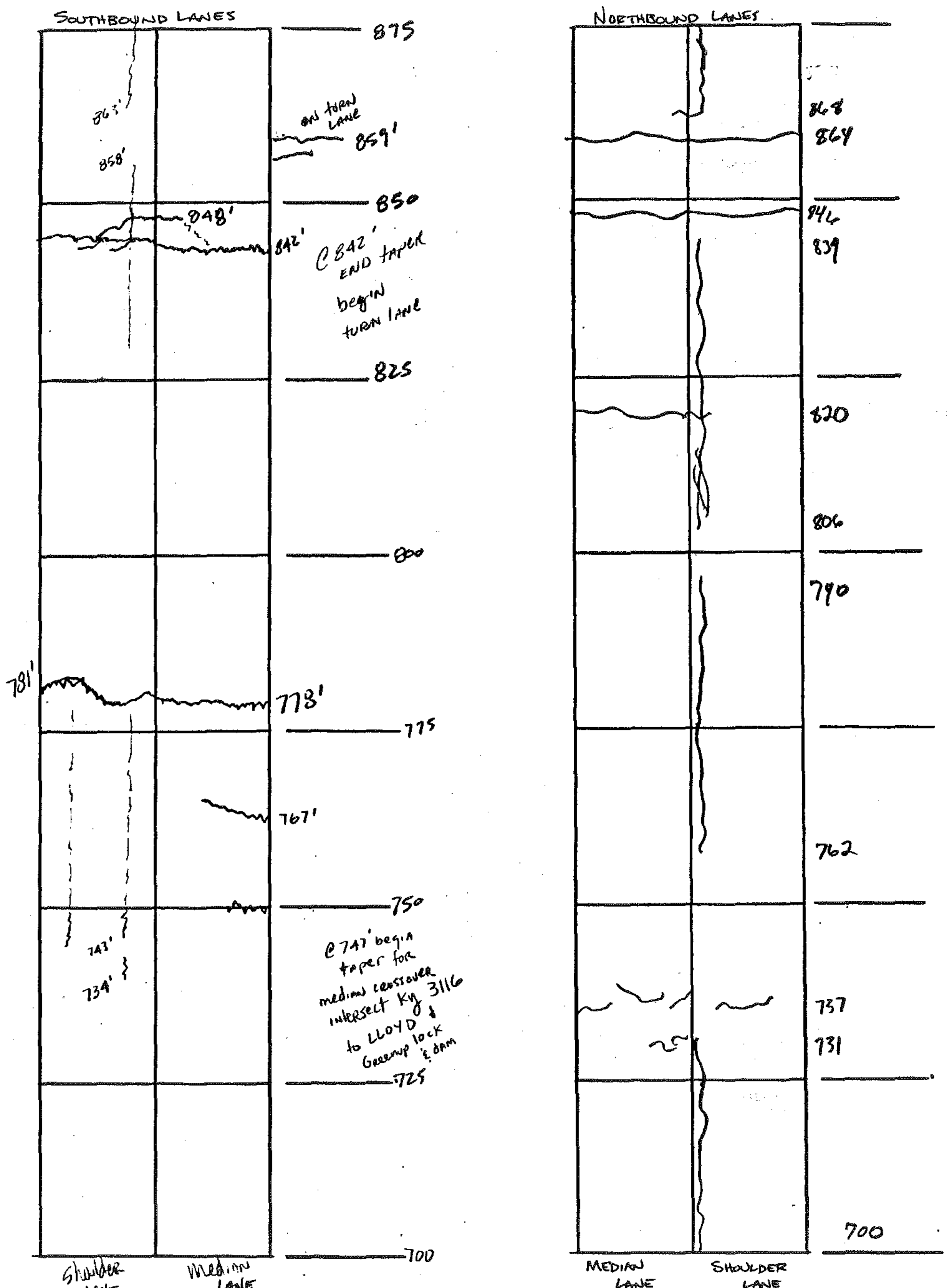
DESIGN SECTION D



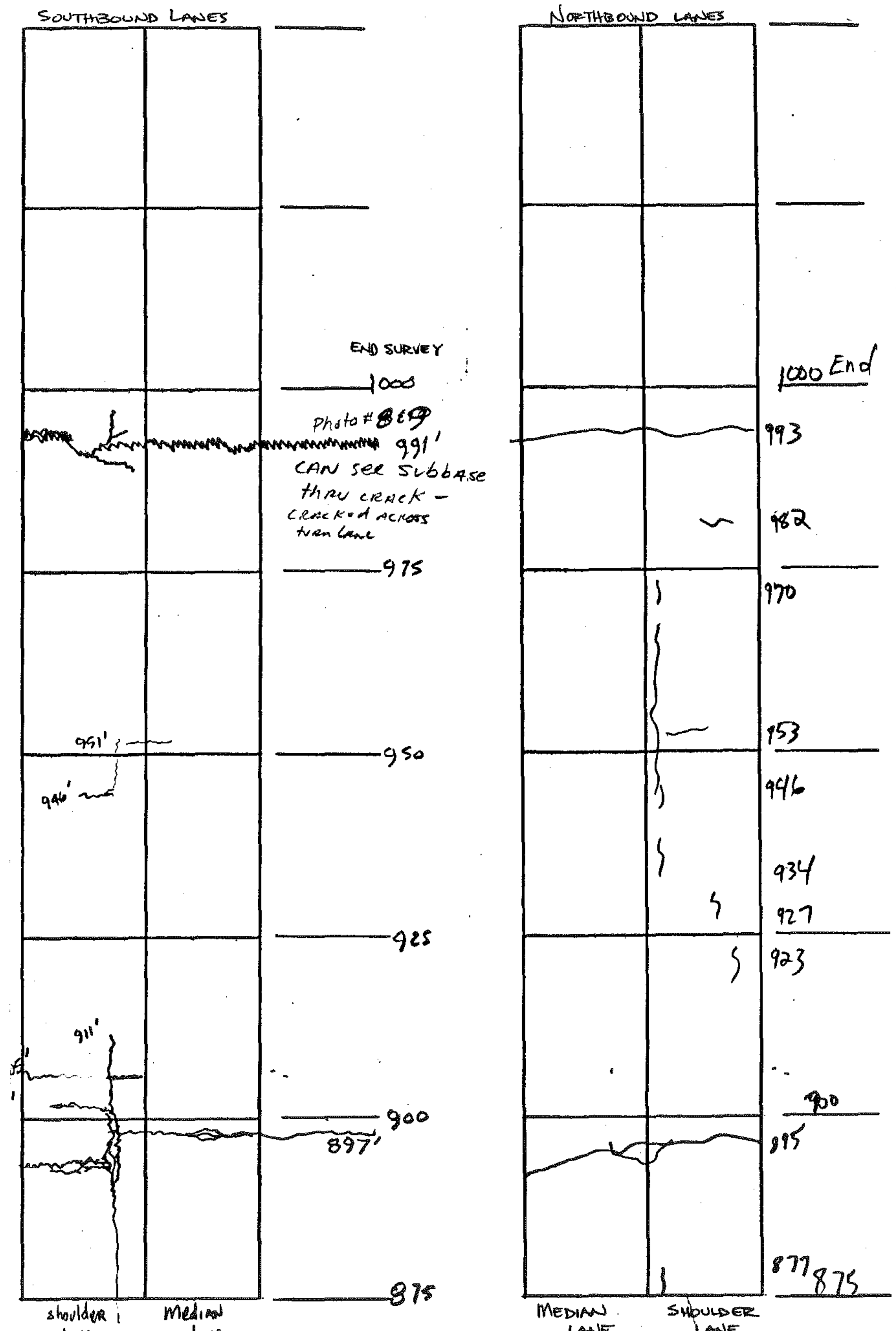
U.S. 23 GREENUP COUNTY
DESIGN SECTION D

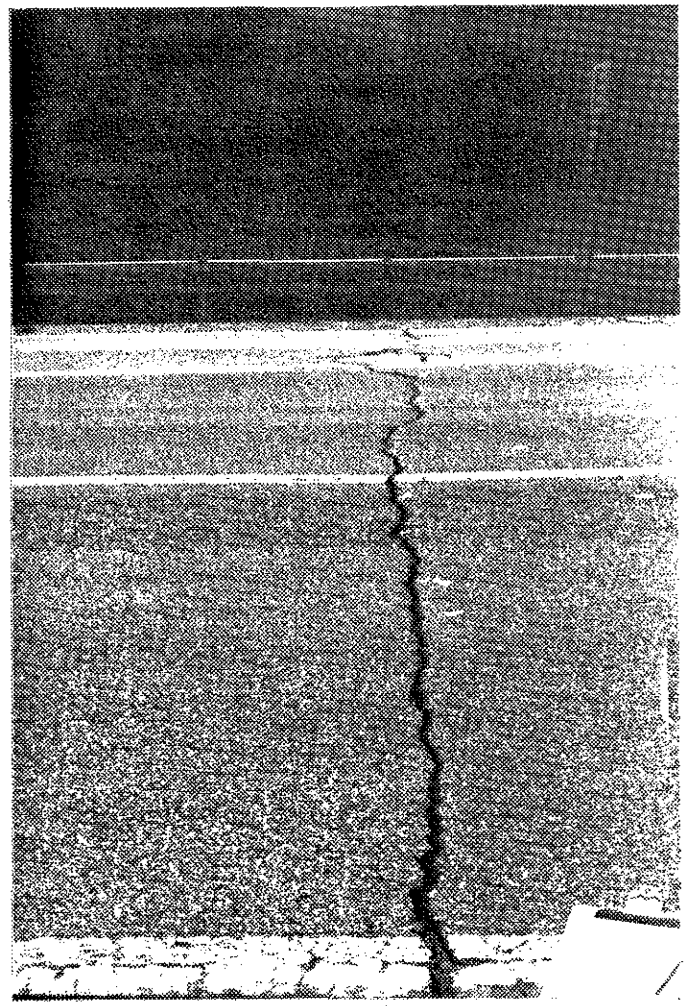


U.S. 23 GREENUP COUNTY
DESIGN SECTION D

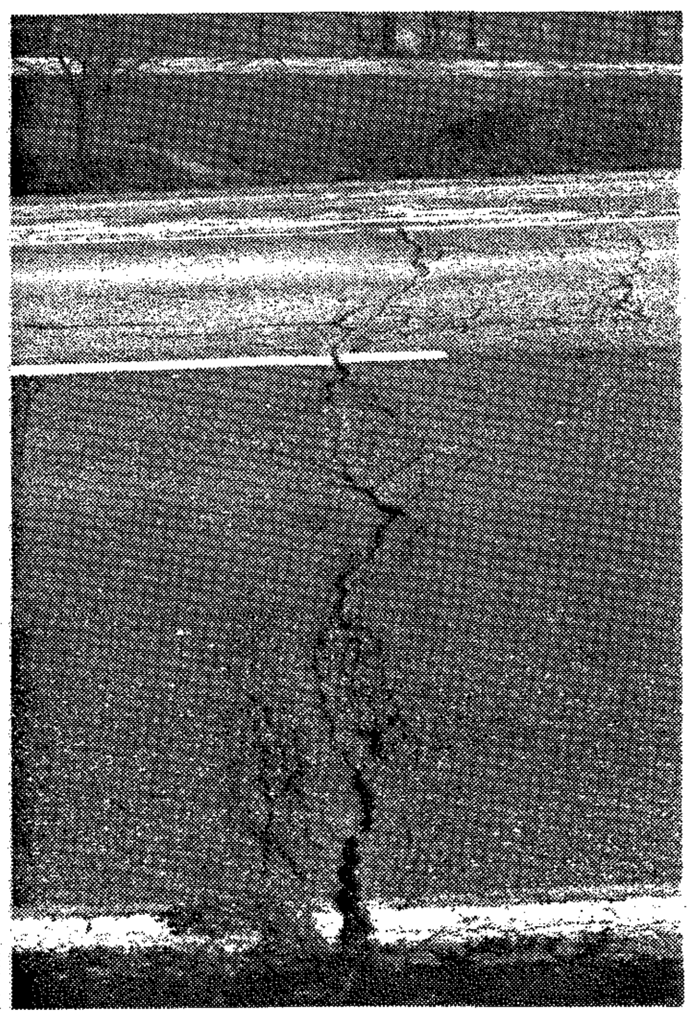


U.S. 23 GREENUP COUNTY
DESIGN SECTION D

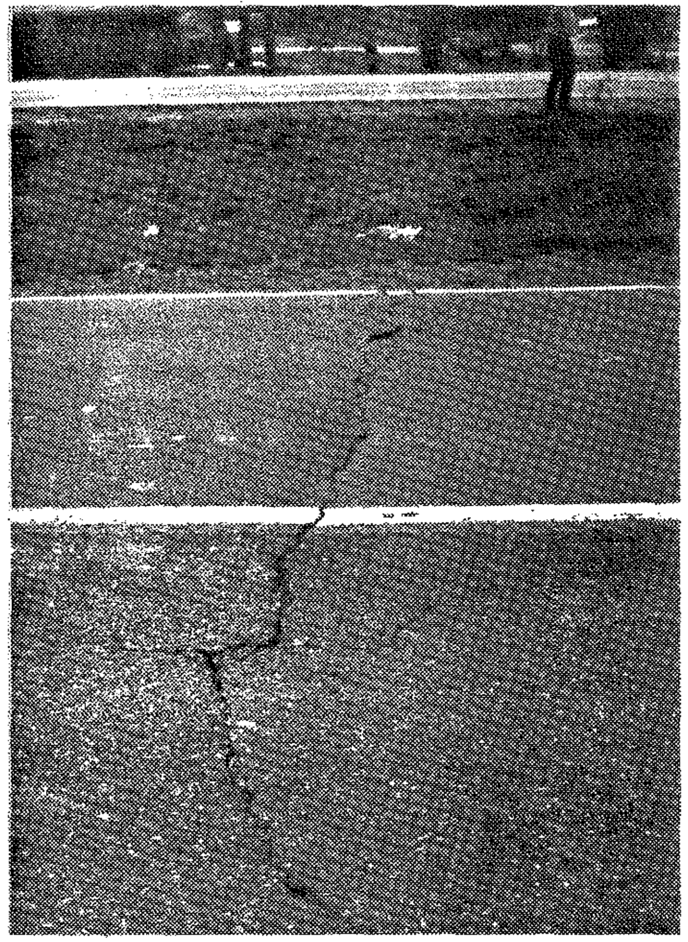




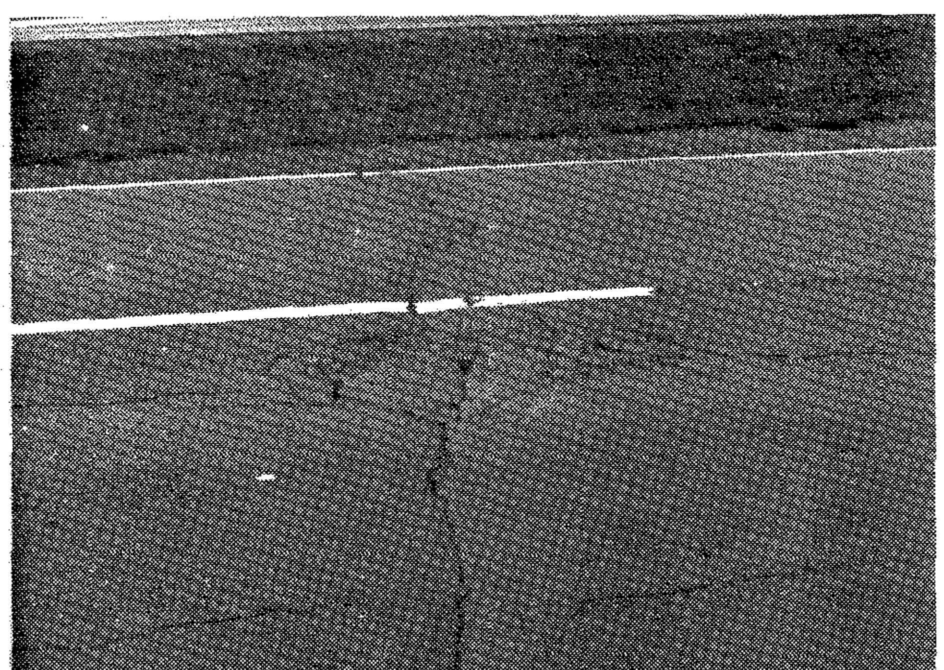
Section D - SB lanes at 166 ft.



Section D - SB lanes at 991 ft.



Section D - NB lanes at milepost 14.



Section D - NB lanes at 297 ft.

SECTION D Northbound MP. 14.0 to 14.0 + 1000 ft.

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
1	0+00	0+44		longitudial	44'	
2			0+36	transverse	12'	
3			0+53	longitudial	2'	
4	0+66	0+78		"	12'	
5			0+70	transverse	6'	
6			0+89	longitudial	2'	
7			0+99	transverse	2'	
8			1+07	longitudial	2'	
9			1+08	transverse	12'	
10			1+13	Alligator		12'
11			1+32	longitudial	4'	
12			1+61	transverse	24'	
13			2+12	"	24'	
14			2+63	"	12'	
15	2+77	3+14		longitudial	37'	
16			2+97	transverse	24'	
17			2+97	Alligator		9'
18			3+34	transverse	15'	
19			3+34	Alligator		6'
20	3+34	3+42		longitudial	8'	
21			3+42	transverse	24'	
22	3+57	3+66		longitudial	9'	
23			3+78	transverse		
24			3+89	"	24'	

SECTION D Northbound MP. 14.0 to 14.0 + 1000 Ft.

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
25	3+89	4+12		longitudial	23'	
26			4+16	transverse	24'	
27			4+16	Alligator		3'
28			4+33	longitudial	2'	
29			4+37	"	4'	
30			4+54	transverse	12'	
31	4+54	4+66		Alligator		24'
32			4+60	transverse	8'	
33			4+66	"	4'	
34			4+90	"	5'	
35	4+90	5+02		longitudial	12'	
36			4+97	transverse	5'	
37	5+11	5+21		longitudial	10'	
38	5+99	6+04		longitudial	5'	
39			6+00	transverse	12'	
40			6+04	"	12'	
41			6+31	transverse	24'	
42	6+38	7+31		longitudial	93'	
43			6+84	transverse	12'	
44			7+37	transverse	18'	
45	7+62	7+90		longitudial	28'	
46	8+06	8+39		"	33'	
47			8+20	transverse	14'	
48			8+46	"	24'	

SECTION D Northbound MP. 14.0 to 14.0 + 1000 ft

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
49			8+64	transverse	24'	
50	8+68	8+77		longitudial	9'	
51			8+95	transverse	24'	
52			9+23	longitudial	3'	
53			9+27	"	3'	
54			9+34	"	3'	
55	9+46	9+70		"	24'	
56			9+82	transverse	3'	
57			9+93	"	24'	
				End		

SECTION D - US23 SB   MP. 14.0 to 14 + 1000 FT TO NORTH
GREENUP COUNTY

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
1	0+00	0+12		LONGITUDINAL CRACK	12	
2			0+12	TRANSVERSE / ALIGATOR	24	4
3			0+13	TRANSVERSE CRACK	10	
4	0+17	0+24		LONGITUDINAL CRACK	7	
5	0+27	0+32		LONGITUDINAL CRACK	5	
6	0+35	0+41		LONGITUDINAL CRACK	6	
7	0+37	1+71		LONGITUDINAL CRACK	134	
8			0+69	TRANSVERSE CRACK	14	
9			0+73	TRANSVERSE / ALIGATOR	15	2
10	1+12	1+13		RANDOM TRANSVERSE	24	
11			1+66	TRANSVERSE / ALIGATOR	24	8
12			1+71	TRANSVERSE / ALIGATOR	10	2
13	1+66	1+71		LONGITUDINAL CRACK	5	
14			2+16	TRANSVERSE CRACK	18	
15			2+19	RANDOM TRANSVERSE	14	
16			2+74	TRANSVERSE CRACK	2	
17	3+08	3+14		LONGITUDINAL CRACK	6	
18	3+26	3+43		LONGITUDINAL CRACK	17	
19	3+38	3+41		TRANSVERSE / ALIGATOR	24	14
20			3+55	TRANSVERSE CRACK	2	
21	3+71	3+85		LONGITUDINAL CRACK	14	
22			3+94	RANDOM TRANSVERSE	12	
23			3+97	RANDOM TRANSVERSE	18	
24			4+49	TRANSVERSE CRACK	7	

SECTION D-US23SB MP. 14 to 14 + 1000 FT TO NORTH
GREENUP COUNTY

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
25			4+77	TRANSVERSE CRACK	22	
26			5+31	TRANSVERSE CRACK	24	
27	5+48	5+63		LONGITUDINAL CRACK	15	
28			5+63	TRANSVERSE CRACK	3	
29	5+68	5+78		LONGITUDINAL CRACK	10	
30			5+78	TRANSVERSE/ALIGATOR	12	2
31	5+84	6+30		ALIGATOR CRACKING		115
32			6+15	TRANSVERSE/ALIGATOR	12	10
33			6+20	TRANSVERSE/ALIGATOR	13	4
34	6+41	6+89		ALIGATOR CRACKING		120
35			6+89	TRANSVERSE/ALIGATOR	20	4
36			6+90	RANDOM TRANSVERSE	8	
37	7+34	7+36		LONGITUDINAL CRACK	2	
38	7+43	7+78		LONGITUDINAL CRACK	35	
39	7+43	7+78		LONGITUDINAL CRACK	35	
40			7+50	TRANSVERSE CRACK	4	
41			7+67	RANDOM TRANSVERSE	8	
42	7+78	7+81		RANDOM TRANSVERSE	24	
43			8+42	TRANSVERSE CRACK	24	
44	8+30	8+58		LONGITUDINAL CRACK	28	
45			8+48	RANDOM TRANSVERSE	9	
46			8+58	TRANSVERSE CRACK	4	
47			8+59	TRANSVERSE CRACK	8	
48	8+63	9+11		LONGITUDINAL CRACK	48	

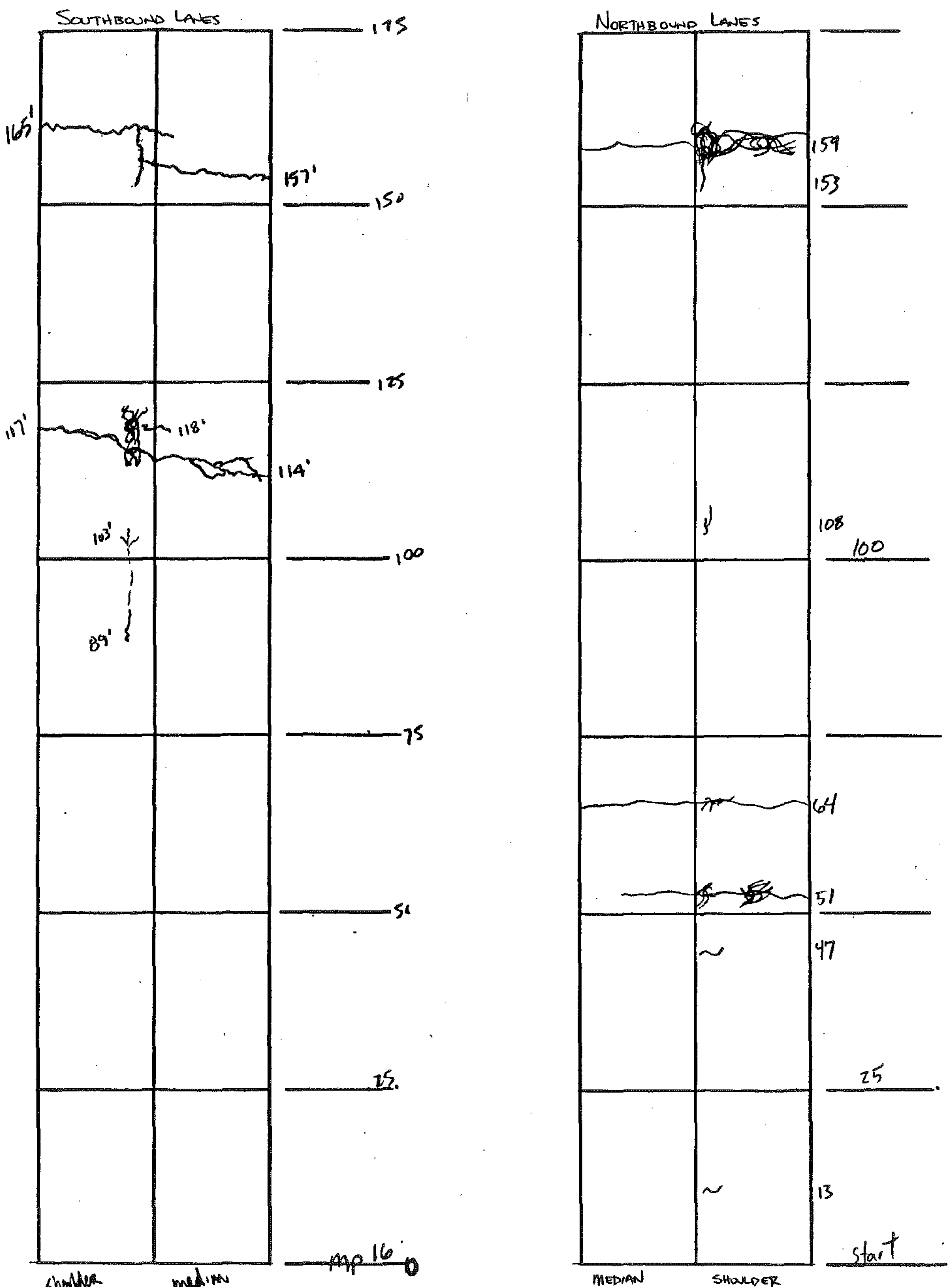
SECTION D - US23SB MP. 14 to 14 - 1000 FT TO NORTH

Greenup County

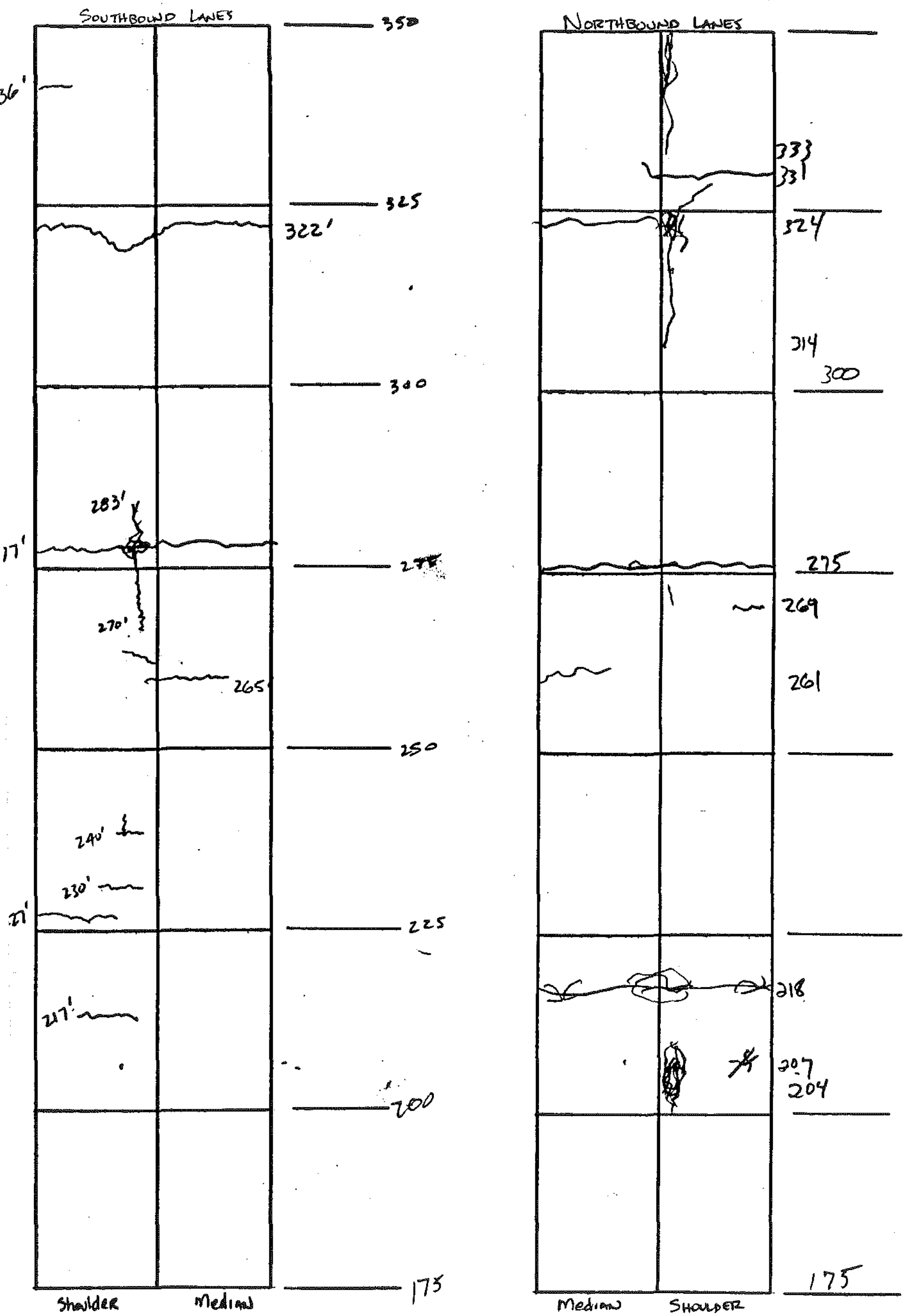
DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
49			8+93	TRANSVERSE / ALIGATOR	9	6
50			8+97	TRANSVERSE / ALIGATOR	25	6
51	8+91	9+01		ALIGATOR CRACKING		28
52			9+01	TRANSVERSE CRACKING	6	
53			9+05	TRANSVERSE CRACKING	6	
54			9+46	TRANSVERSE CRACKING	3	
55	9+46	9+51		LONGITUDINAL CRACKING	5	
56			9+51	TRANSVERSE CRACKING	4	
57			9+91	RANDOM TRANSVERSE	34	
58			9+91	ALIGATOR CRACKING		6

APPENDIX E

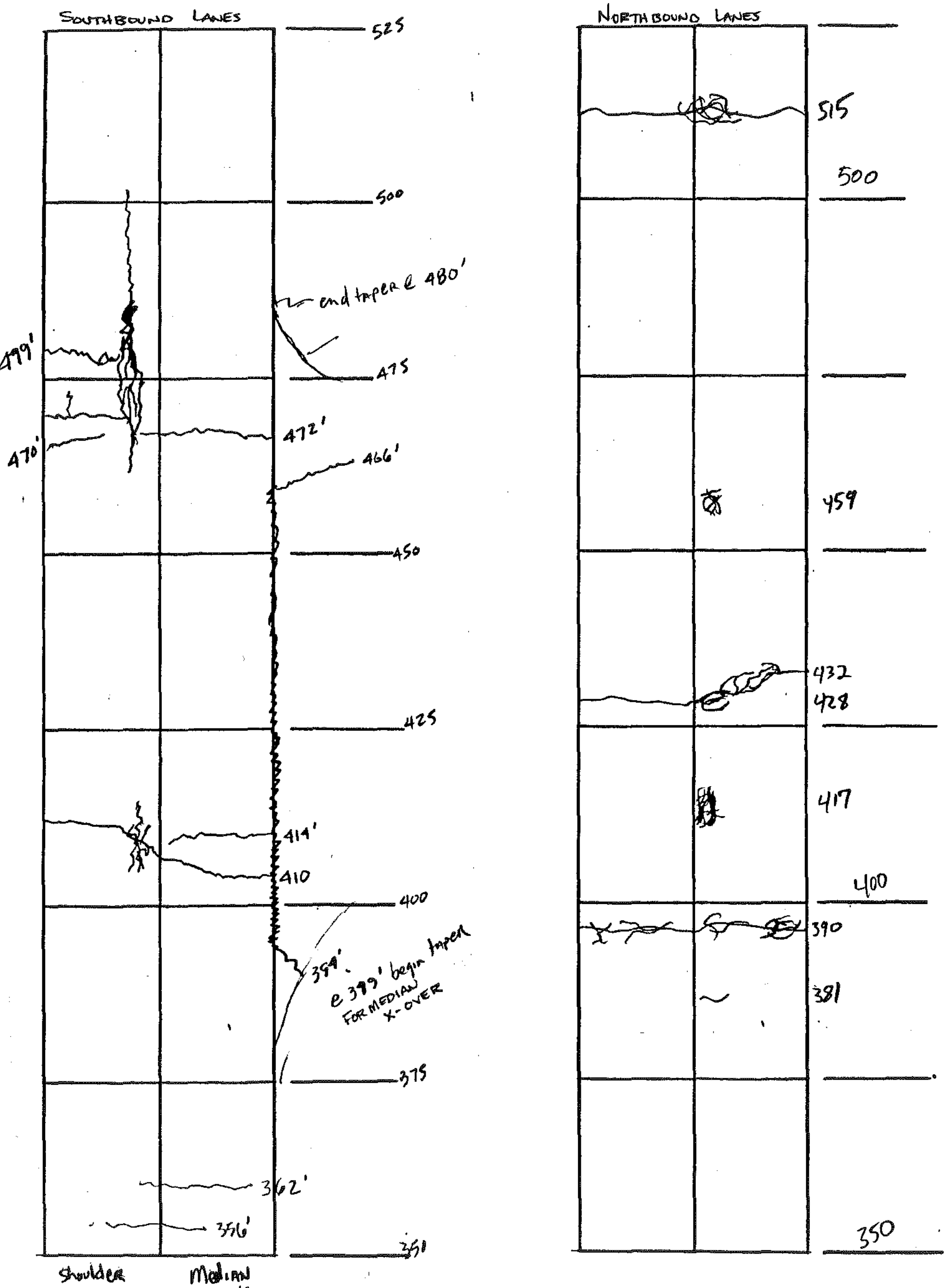
U.S. 23 GREENUP COUNTY
DESIGN SECTION E



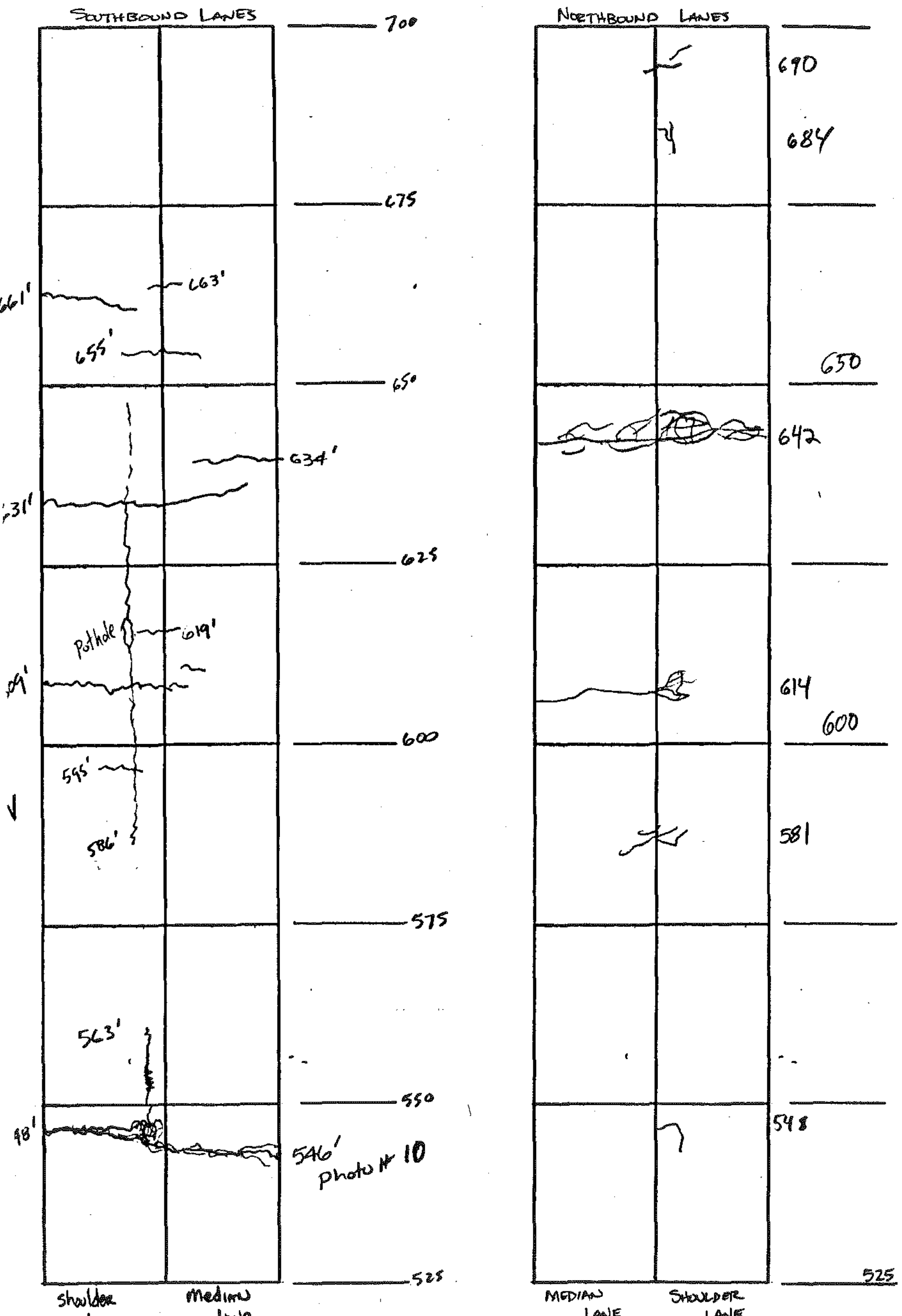
U.S. 23 GREENUP COUNTY
DESIGN SECTION E



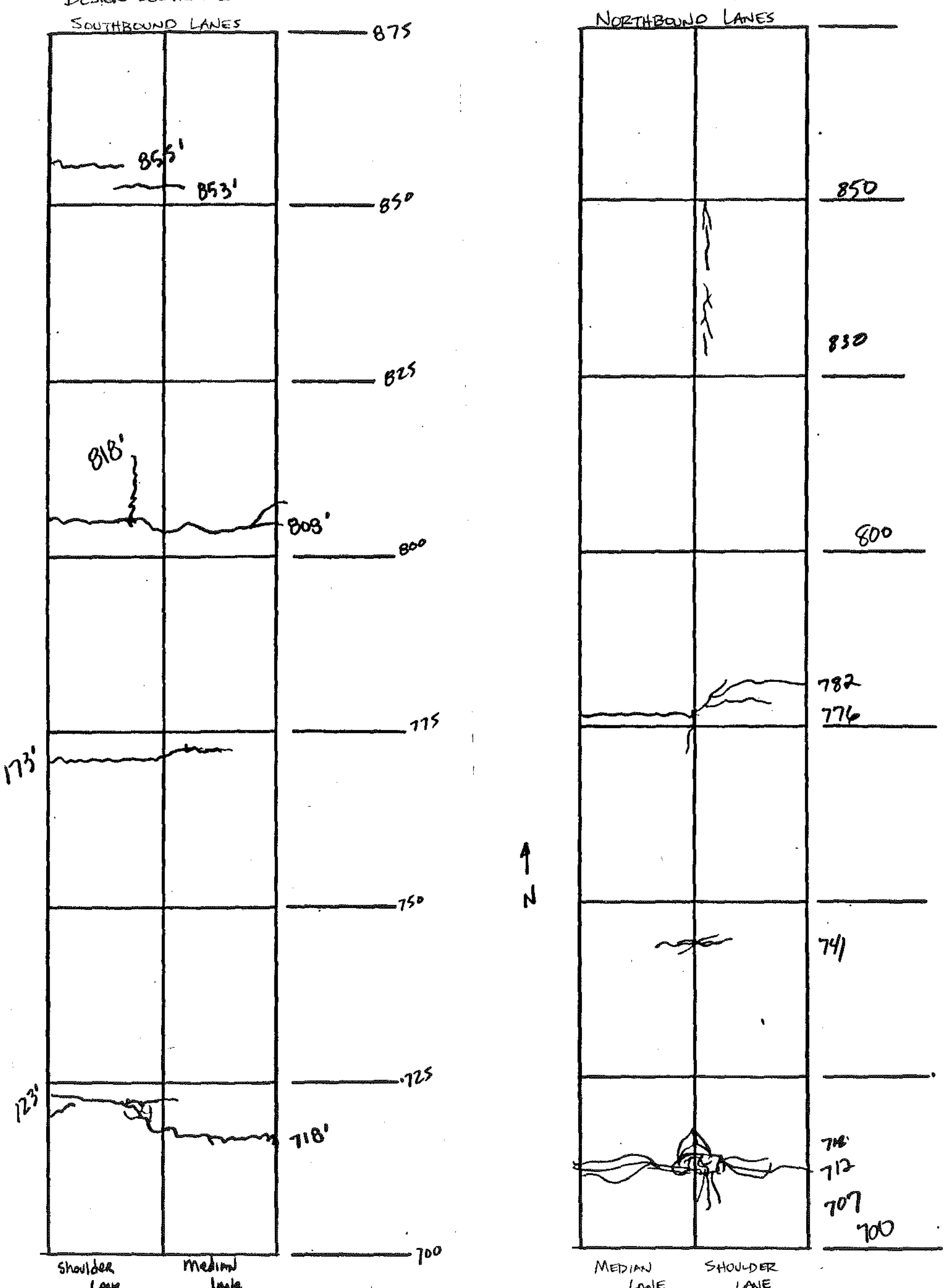
U.S. 23 GREENUP COUNTY
DESIGN SECTION E



U.S. 23 GREENUP COUNTY
DESIGN SECTION E

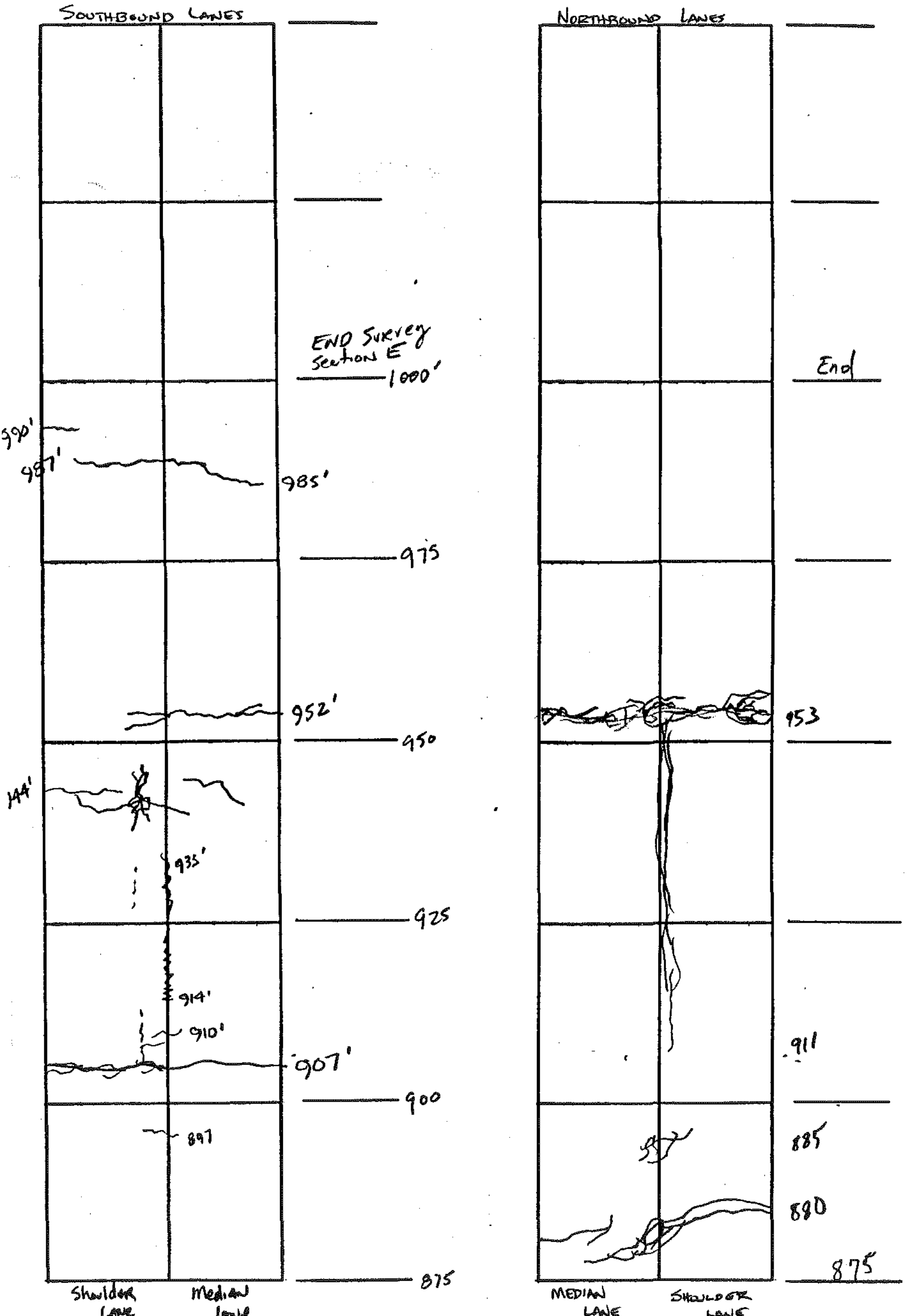


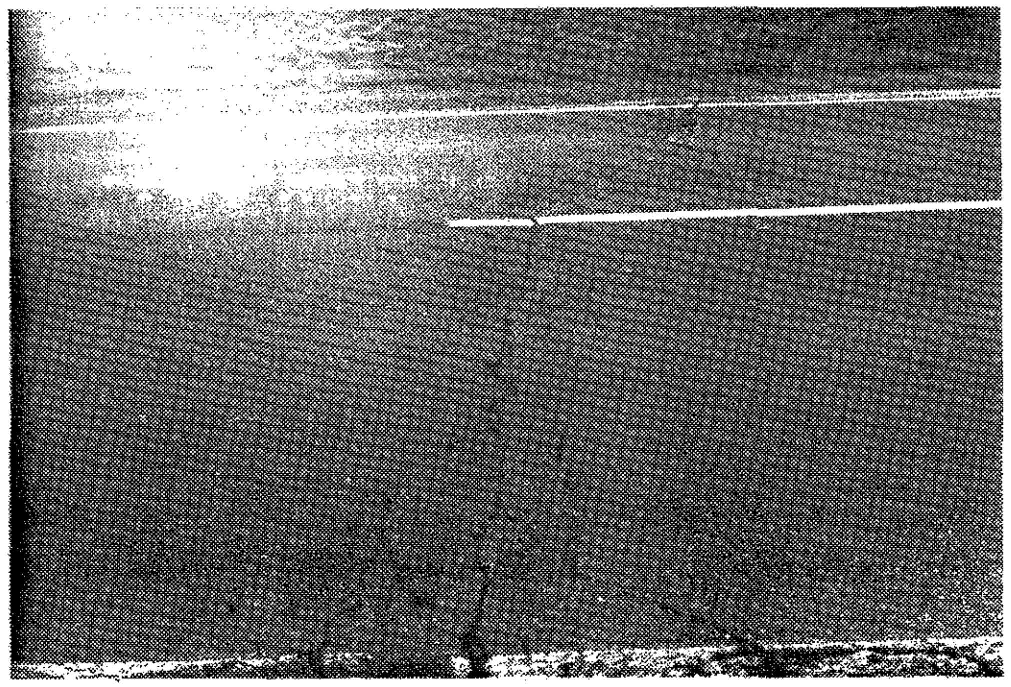
U.S. 23 GREENUP COUNTY
DESIGN SECTION E



U.S. 23 GREENUP COUNTY

DESIGN SECTION E





Section E - SB lanes at 546 ft.

SECTION E Northbound MP. 16.0 to 16.0 + 1000 ft

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
1			0+13	transverse	2'	
2			0+47	"	2'	
3			0+51	"	17'	
4			0+51	Alligator		8'
5			0+64	transverse	24'	
6			1+08	longitudial	4'	
7	1+53	1+59		"	6'	
8			1+59	transverse	24'	
9			1+59	Alligator		24'
10	2+04	2+07		"	9'	
11			2+18	transverse	24'	
12			2+61	"	8'	
13			2+69	"	4'	
14			2+75	"	24'	
15	3+14	3+31		longitudial	17'	
16			3+24	transverse	12'	
17			3+31	"	14'	
18	3+33	3+50		longitudial	17'	
19			3+81	transverse	3'	
20			3+90	"	24'	
21			4+17	Alligator		8'
22			4+28	transverse	12'	
23			4+32	"	12'	
24	4+28	4+32		Alligator		6'

SECTION E Northbound MP. 16.0 to 16.0 + 1000ft

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
25			4+59	Alligator		2'
26			5+15	transverse	24'	
27			5+15	Alligator		10'
28			5+48	transverse	3'	
29			5+81	"	6'	
30			6+14	"	14'	
31			6+42	Alligator		48'
32			6+84	longitudial	3'	
33			6+90	transverse	3'	
34			7+12	Alligator		72'
35			7+41	transverse	7'	
36			7+76	"	12'	
37			7+82	"	12'	
38	8+30	8+50		longitudial	20'	
39			8+80	transverse	24'	
40'			8+80	Alligator		18'
41			8+85	"		6'
42	9+11	9+53		longitudial	42	
43			9+53	Alligator		72'
				End		

SECTION E - US23 SB MP. 16 to 16 + 1000 FT TO NORTH

Greenup County

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
1	0+89	1+03		Longitudinal	14	
2	1+14	1+17		Random Transverse	24	
2a			1+15	Aligator Cracking		9
3	1+14	1+20		Aligator Cracking		15
4			1+18	Transverse Crack	2	
5			1+57	Transverse Crack	13	
6	1+54	1+63		Longitudinal Crack	9	
7			1+65	Transverse Crack	13	
8			2+17	Transverse Crack	6	
9			2+27	Transverse Crack	8	
10			2+30	Transverse Crack	4	
11			2+40	Transverse Crack	3	
12	2+40	2+42		Longitudinal Crack	2	
13			2+65	Transverse Crack	7	
14	2+66	2+68		Random Transverse	4	
15	2+70	2+83		Longitudinal Crack	13	
16			2+77	Transverse/Aligator	24	2
17			3+22	Transverse Crack	24	
18			3+36	Transverse Crack	4	
19			3+56	Transverse Crack	10	
20			3+62	Transverse Crack	12	
21	3+94	4+66		Longitudinal Crack	72	
22	4+10	4+15		Random Transverse	24	
23			4+14	Transverse Crack	11	

SECTION E US23SB MP. 16 to 16 + 1000 FT TO NORTH

Greenup County

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
24	4+10	4+16		Longitudinal/Aligator	6	7.5
25			4+72	Transverse Crack	13	
26			4+70	Transverse Crack	5	
27			4+73	Transverse Crack	7	
28	4+72	4+85		Aligator Crack		325
29	4+66	4+74		Longitudinal Crack	8	
30	4+80	5+02		Longitudinal Crack	22	
31	5+46	5+48		Drifting Aligator Crack		24
32	5+49	5+63		Longitudinal Crack	14	
33	5+86	6+49		Longitudinal Crack	63	
34			5+95	Transverse Crack	5	
35			6+09	Transverse Crack	13	
36			6+19	Transverse Crack	4	
37			6+31	Transverse Crack	22	
38			6+34	Transverse Crack	10	
39			6+55	Transverse Crack	8	
40			6+61	Transverse Crack	10	
41			6+63	Transverse Crack	3	
42			7+18	Transverse Crack	13	
43			7+23	Transverse/Aligator	7	4
44			7+73	Transverse	18	
45			8+08	Transverse	24	
46	8+08	8+18		Longitudinal	10	
47			8+53	Transverse	6	

SECTION E-US 23 SB MP. 16 to 16 + 1000 FT TO NORTH

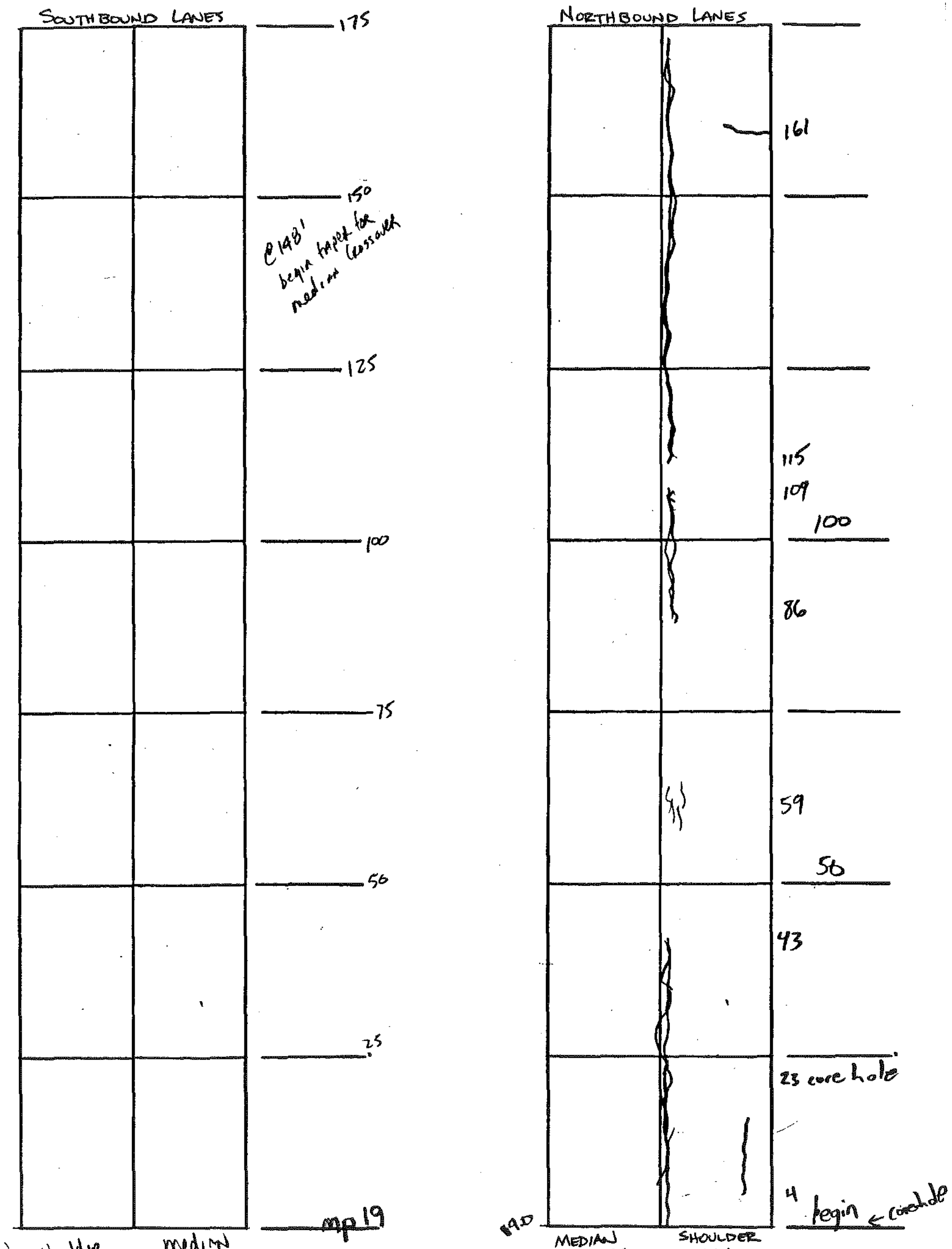
Greenup County

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
48			8+55	Transverse	7	
49			8+97	Transverse	3	
50			9+07	Transverse/Aligator	24	12
51	9+07	9+13		Aligator		6
52	9+14	9+33		Longitudinal	19	
53			9+44	Aligator		13
54	9+43	9+46		Aligator		7.5
55	9+44	9+46		Random Transverse	8	
56			9+52	Transverse/Aligator	15	4
57	9+85	9+87		Random Transverse	21	
58			9+90	Transverse	3	

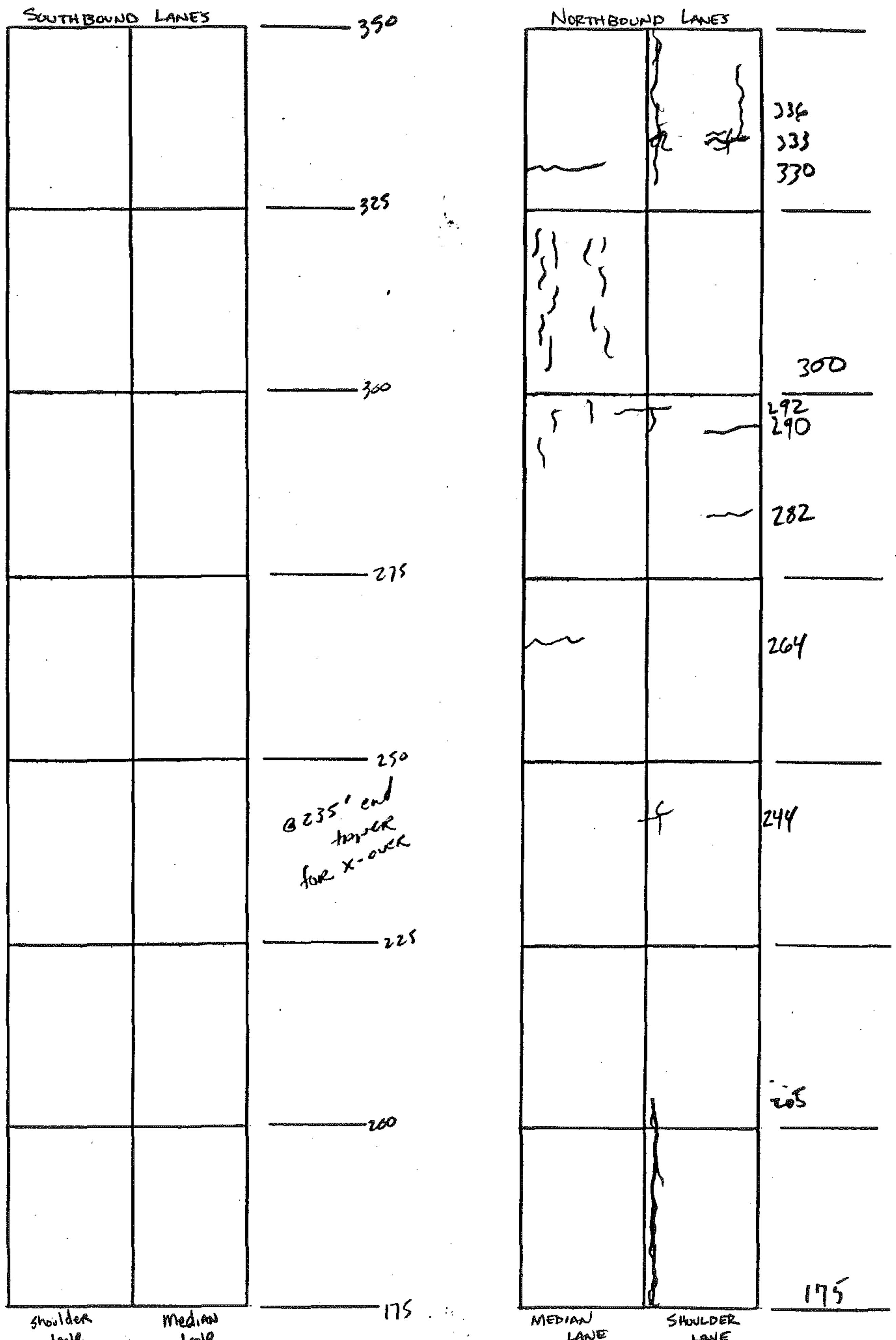
APPENDIX F

U.S. 23 GREENUP COUNTY

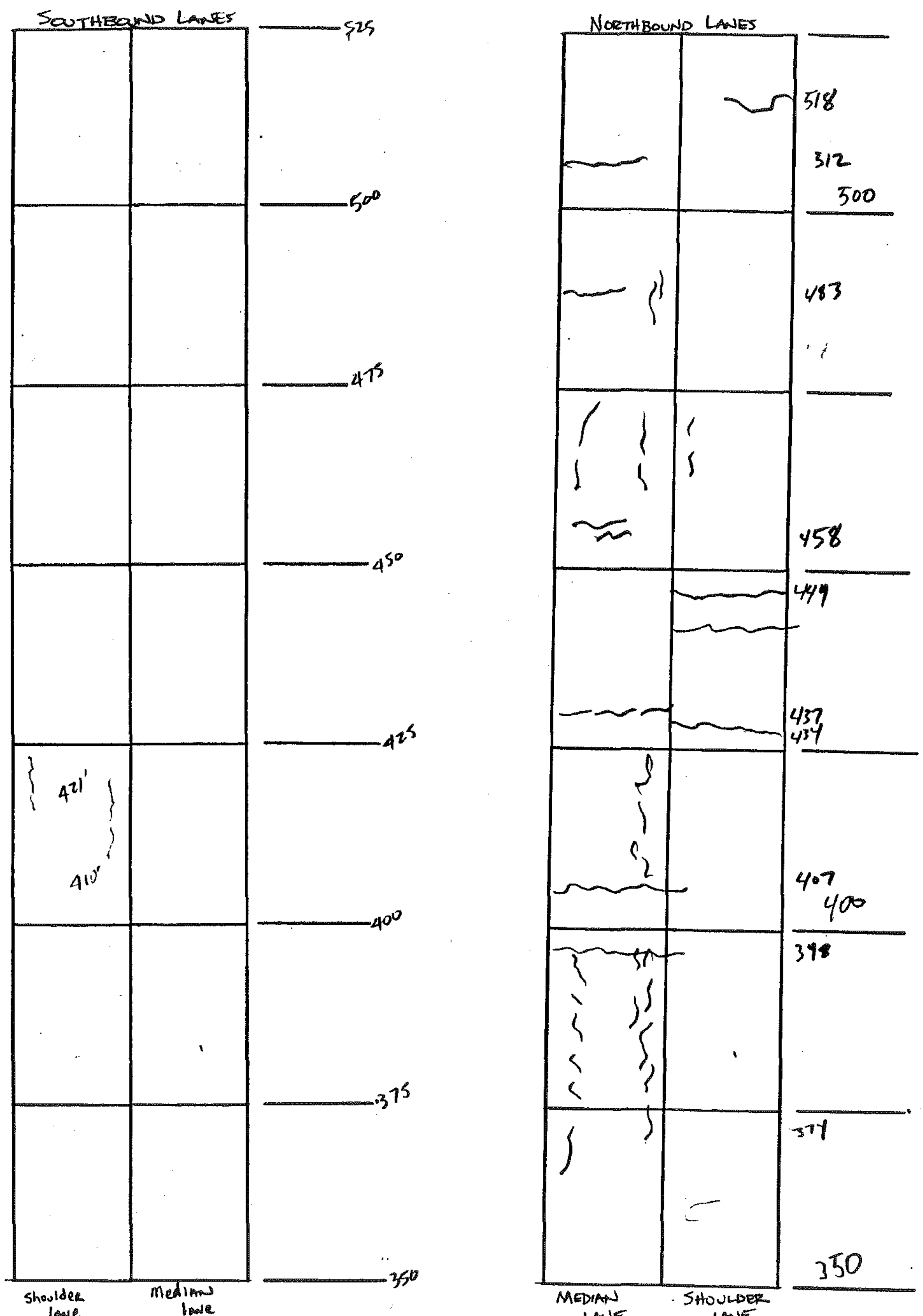
DESIGN SECTION F



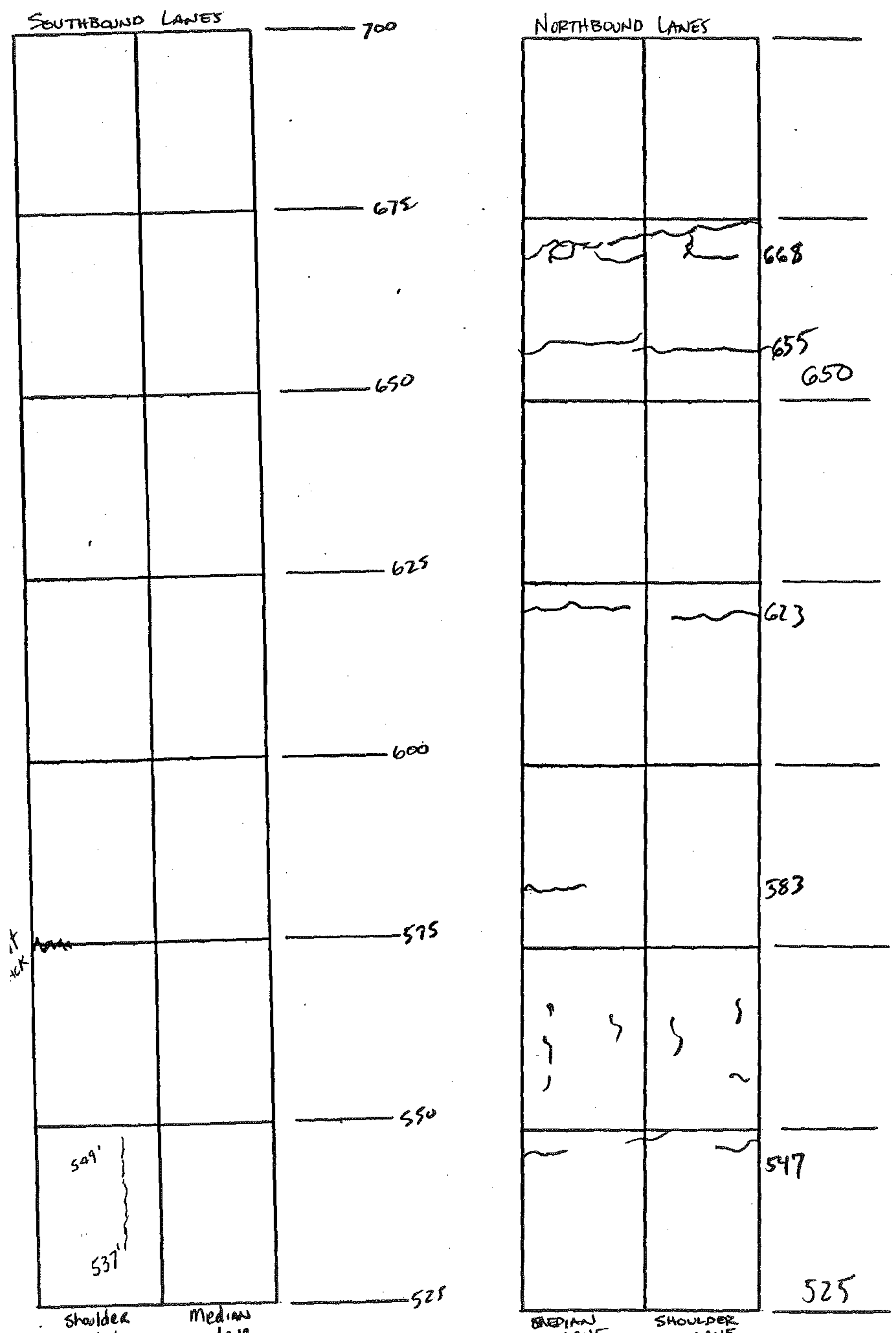
U.S. 23 GREENUP COUNTY
DESIGN SECTION F



U.S. 23 GREENUP COUNTY
DESIGN SECTION F



U.S. 23 GREENUP COUNTY
DESIGN SECTION F



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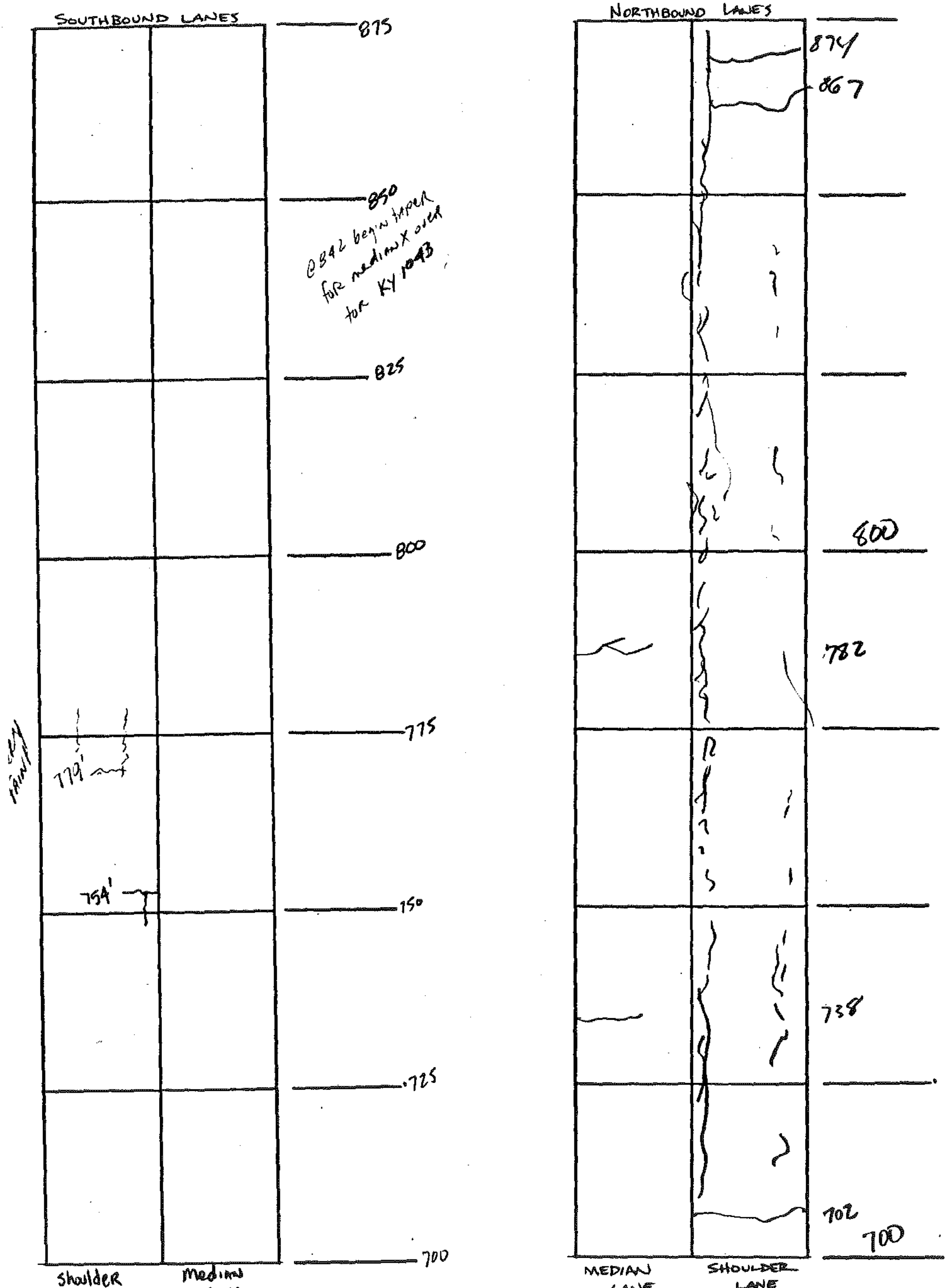
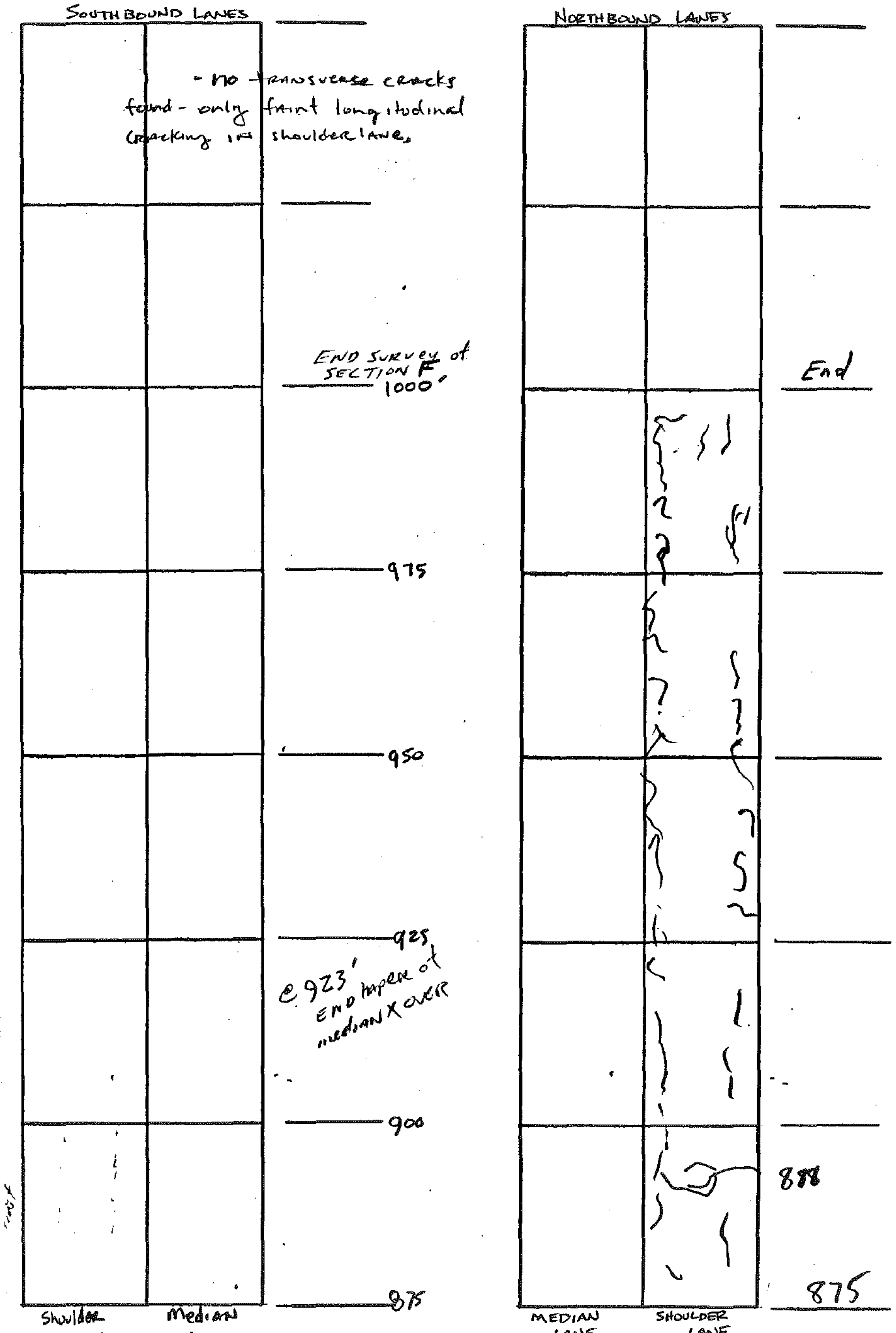
DESIGN SECTION F



U.S. 23 GREENUP COUNTY

DESIGN SECTION F



SECTION F Northbound MP. 19.0 to 19.0 + 1000 ft.

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
1	0+00	0+43		longitudial	43'	
2	0+04	0+17		"	13'	
3			0+59	"	3'	
4	0+86	1+09		"	23'	
5	1+15	2+05		"	90'	
6			2+44	Alligator		4'
7			2+64	transverse	6'	
8			2+82	"	4'	
9			2+90	"	6'	
10			2+92	"	4'	
11	2+92	3+25		Alligator		330'
12			3+30	transverse	8'	
13	3+30	3+50		longitudial	20'	
14	3+33	3+40		"	7'	
15			3+33	Alligator		8'
16	3+74	3+98		"		192'
17			3+98	transverse	14'	
18			4+07	"	14'	
19	4+07	4+25		longitudial	18'	
20			4+34	transverse	12'	
21			4+37	"	12'	
22			4+40	"	12'	
23			4+49	"	12'	
24			4+58	"	6' @ 4'	

SECTION F Northbound MP. 19.0 to 19.0 + 1000 ft.

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
25	4+65	4+75		longitudial	10 @ 8'	
26			4+83	"	5'	
27			4+83	transverse	6'	
28			5+12	"	10'	
29			5+18	"	7'	
30			5+47	"	12'	
31	5+50	5+75		small longitudial cracks in wheelpaths		
32			5+83	transverse	6'	
33			6+23	"	19'	
34			6+55	"	24'	
35			6+68	"	24'	
36			6+68	Alligator		24'
37			7+02	transverse	12'	
38	7+04	10+00		longitudial	296'	
39	7+27	7+45		"	18'	
40			7+38	transverse	6'	
41			7+82	"	7'	
42			8+67	"	10'	
43			8+74	"	10'	
44			8+88	"	10'	
45	9+08	9+15		longitudial	7'	
46	9+30	9+65		"	35'	
47	9+75	9+85		"	10'	
48			9+90	"	4'	

End

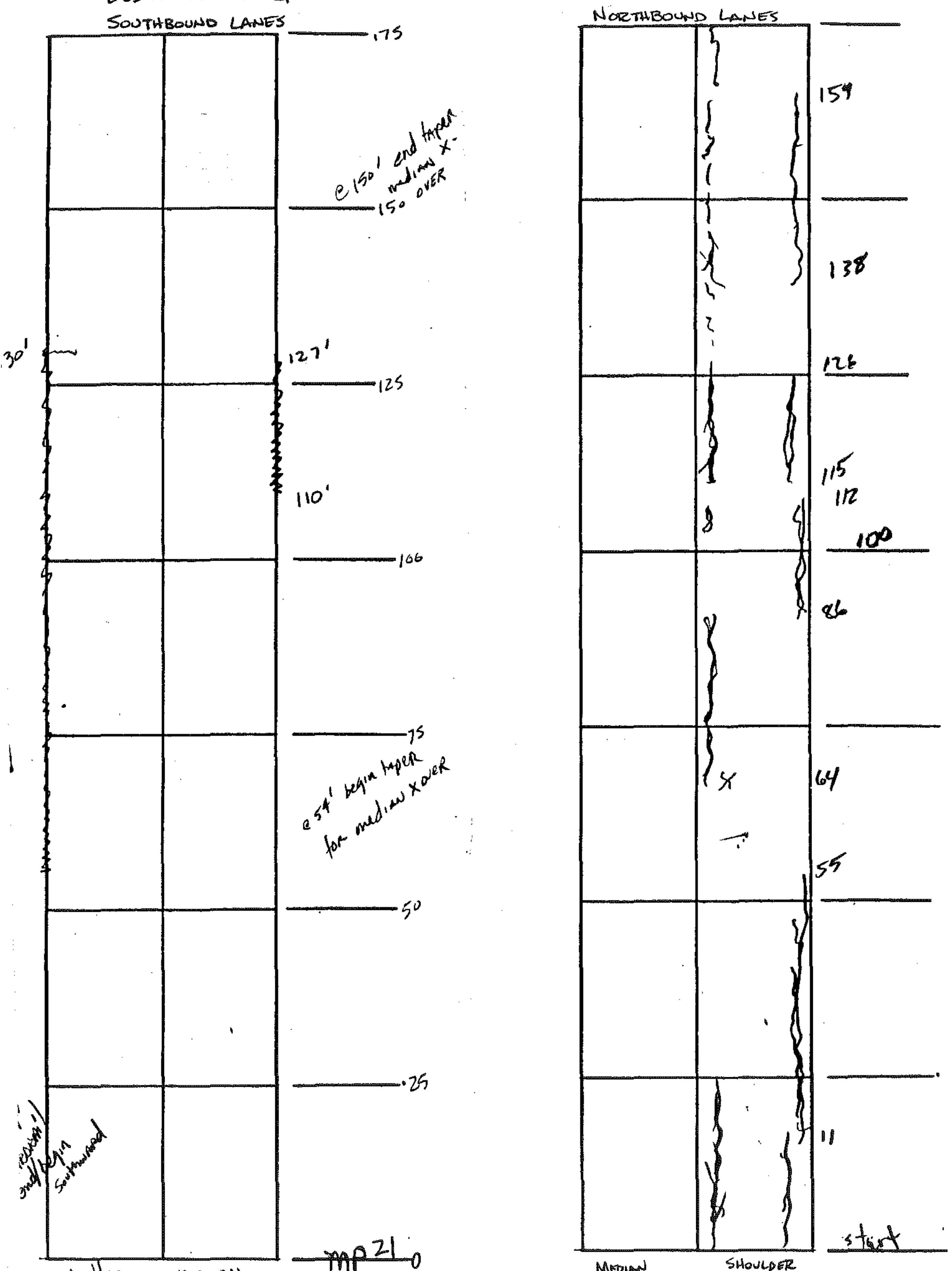
SECTION F - US23SB MP. 19 to 19 + 1000 FT TO NORTH

GREENUP COUNTY

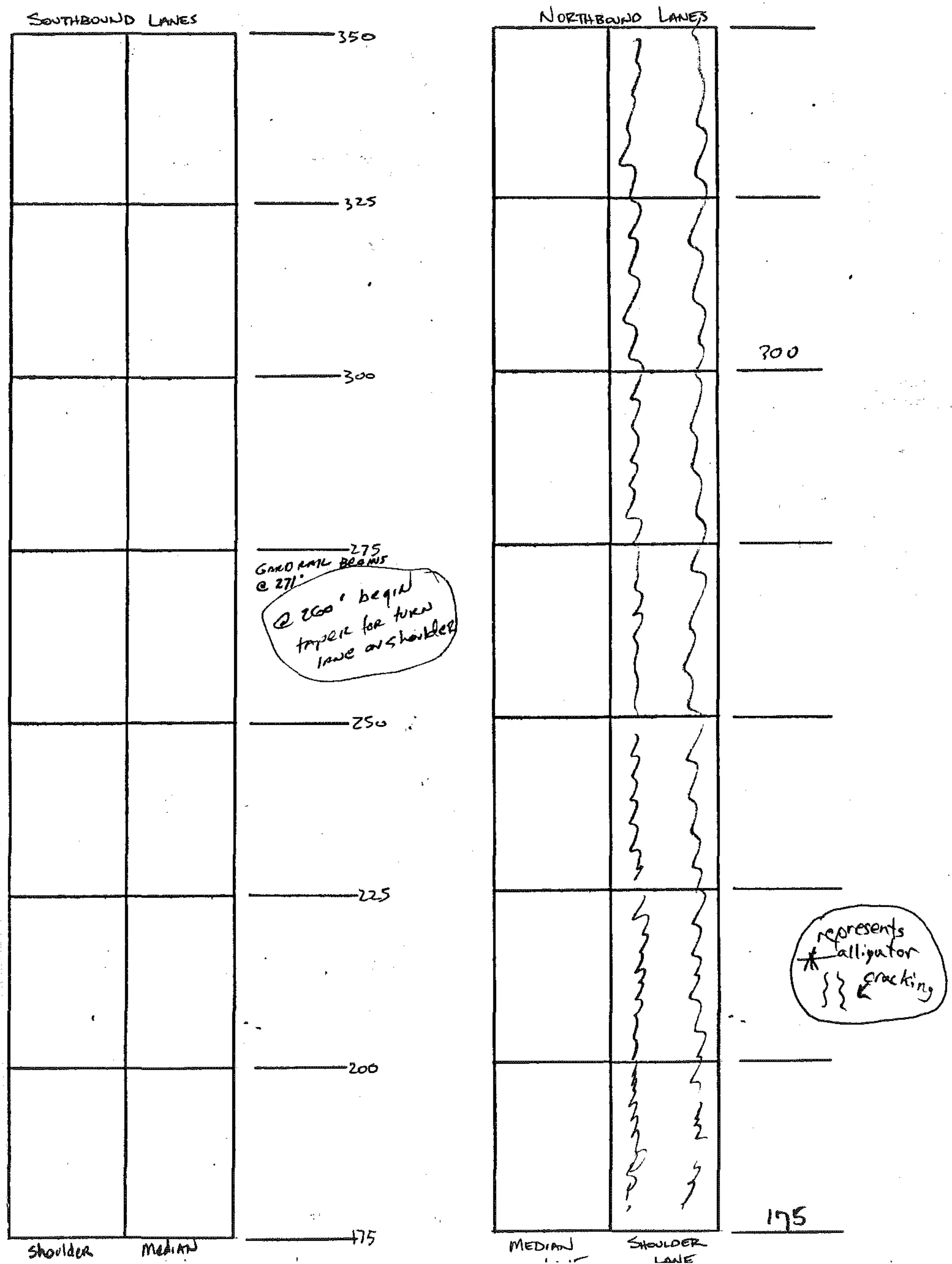
DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
1	4+10	4+21		LONGITUDINAL CRACK	11	
2	4+18	4+23		LONGITUDINAL CRACK	5	
3	5+37	5+49		LONGITUDINAL CRACK	12	
4			5+75	TRANSVERSE CRACK	4	
5	7+49	7+54		LONGITUDINAL CRACK	5	
6			7+54	TRANSVERSE CRACK	3	
7			7+70	TRANSVERSE CRACK	5	
8	7+70	7+79		LONGITUDINAL CRACK	9	
9	7+70	7+79		LONGITUDINAL CRACK	9	
10	8+85	9+00		LONGITUDINAL CRACK	15	
11	8+85	9+00		LONGITUDINAL CRACK	15	

APPENDIX G

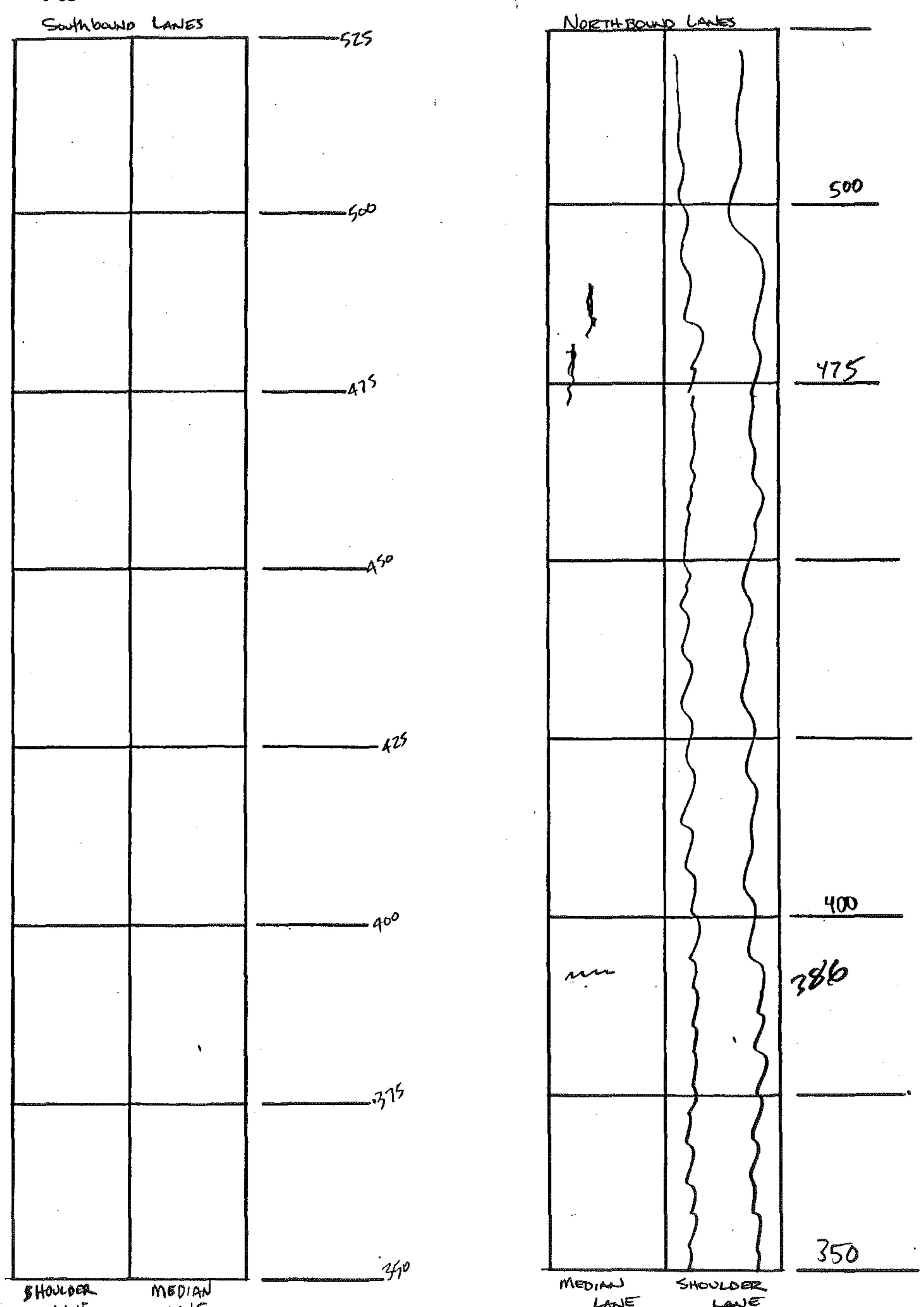
U.S. 23 GREENUP COUNTY
DESIGN SECTION G



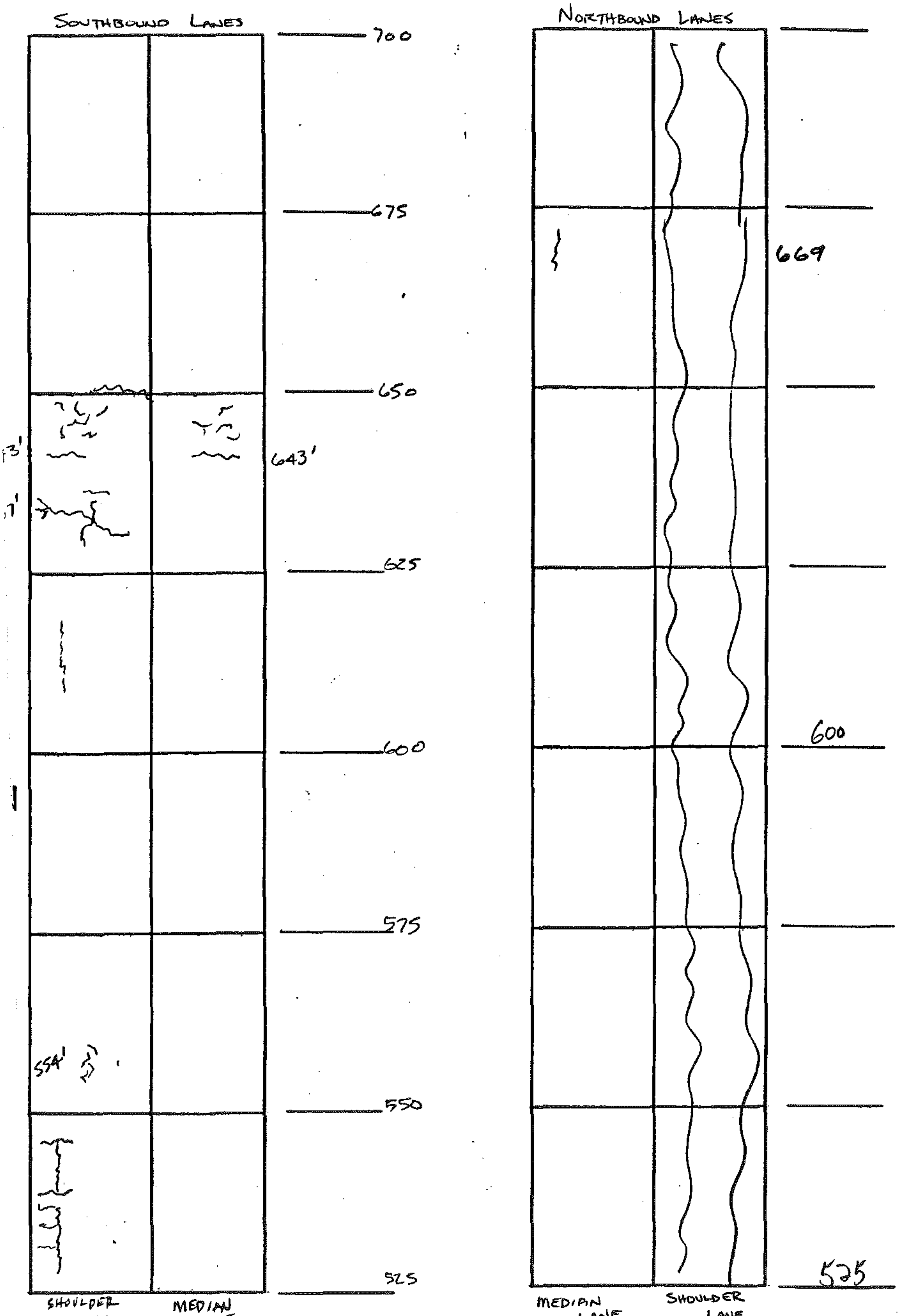
U.S. 23 GREENUP COUNTY
DESIGN SECTION G



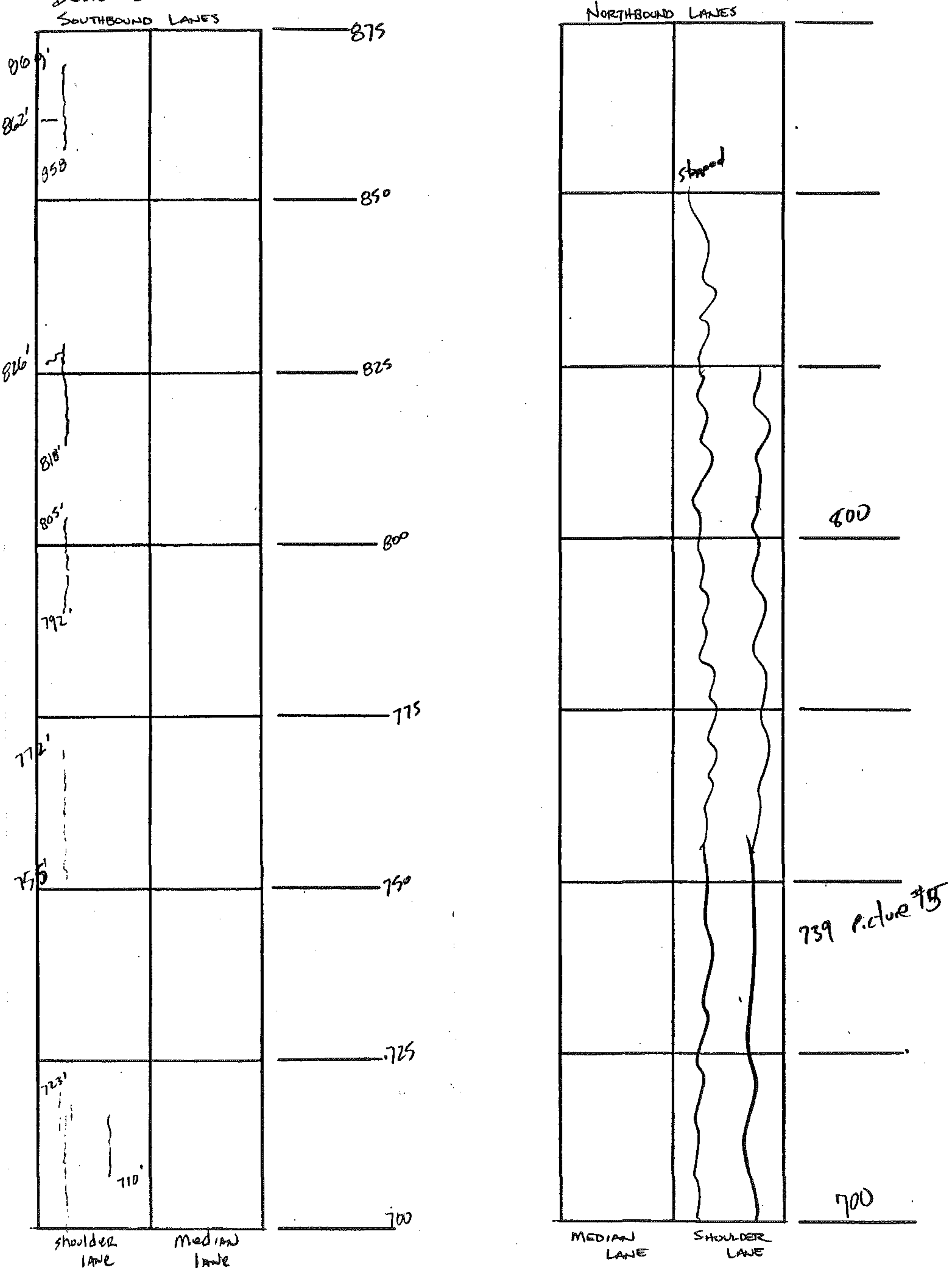
U.S. 23 GREENUP COUNTY
DESIGN SECTION G



U.S. 23 GREENUP COUNTY
DESIGN SECTION G



U.S. 23 Greenup County
Design Section G



U.S. 23 GREENUP COUNTY
DESIGN SECTION G

SOUTHBOUND LANES

Note: Limestone surface in good shape some rutting in shoulder lane - surface appears newer & in much better shape than NB lanes

END SURVEY SECTION G

1000'

975

950

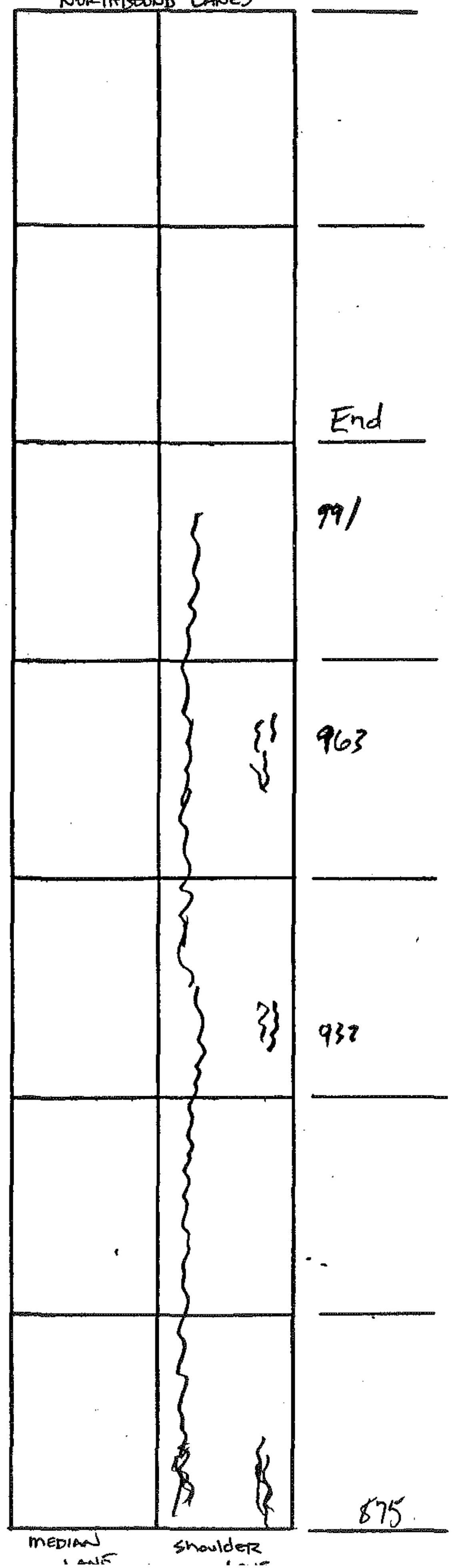
925

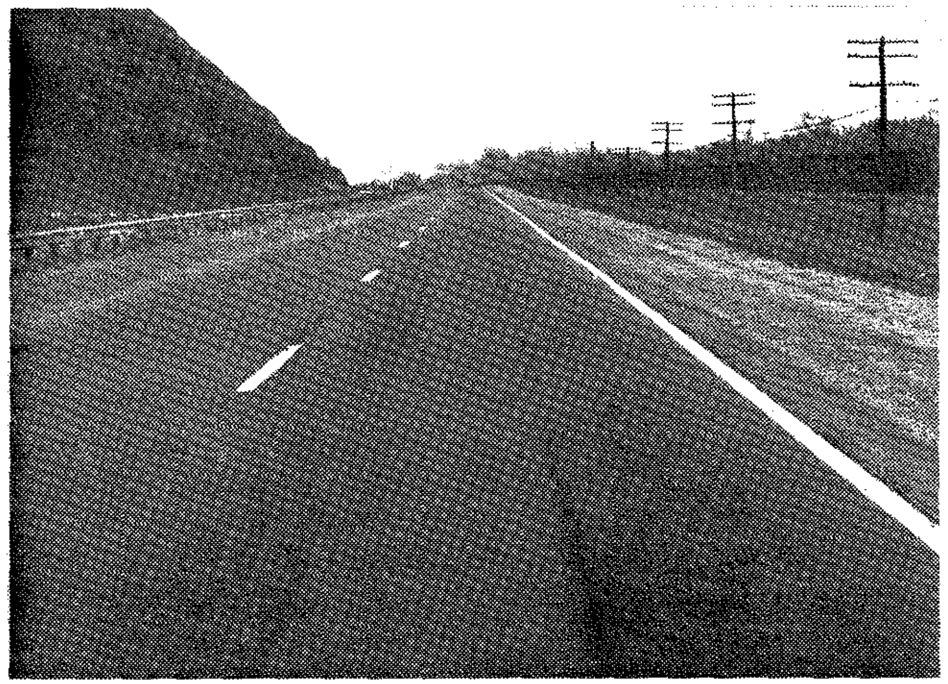
900

875

Shoulder Median

NORTHBOUND LANES





Section G - NB lanes at 739 ft.

SECTION G Northbound MP. 21.0 to 21.0 +1000 ft.

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
1	0+00	0+25		longitudial	25'	
2	0+00	0+55		"	55'	
3	0+64	0+86		"	22'	
4	0+86	1+12		"	26'	
5	1+15	1+26		"	11'@ 11'	
6	1+38	1+59		"	21'	
7	1+38	1+59		"	21'	
8	1+59	8+50		"	691'	
9	1+75	8+25		"	650'	
10			3+86	transverse	5'	
11			4+75	longitudial	4'	
12			6+69	"	5'	
13			9+32	"	4'	
14			9+63	"	8'	

SECTION G-US23SB MP. 21 to 21 + 1000 FT TO NORTH.
GREENUP COUNTY

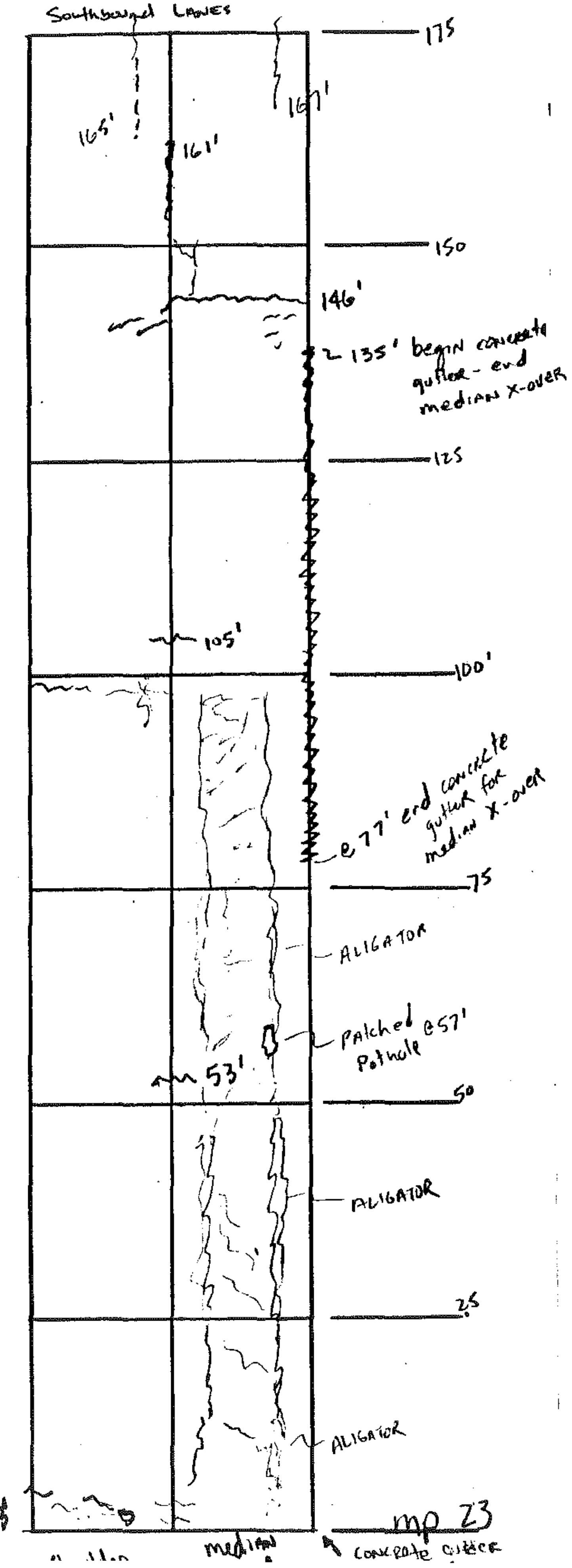
DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
1	0+54	1+30		LONGITUDINAL CRACK	76	
2	1+10	1+27		LONGITUDINAL CRACK	17	
3			1+30	TRANSVERSE CRACK	3	
4	5+30	5+42		LONGITUDINAL CRACK	12	
5			5+34	TRANSVERSE CRACK	2	
6			5+38	TRANSVERSE CRACK	2	
7			5+42	TRANSVERSE CRACK	2	
8	5+44	5+48		LONGITUDINAL CRACK	4	
9			5+44	TRANSVERSE CRACK	3	
10			5+48	TRANSVERSE CRACK	3	
11			5+54	RANDOM CRACKING		8
12	6+10	6+20		LONGITUDINAL CRACK	10	
13			6+37	RANDOM TRANSVERSE CRACK	10	
14			6+39	TRANSVERSE CRACK	2	
15	6+32	6+38		LONGITUDINAL CRACK	6	
16			6+43	TRANSVERSE CRACK	7	
17	6+46	6+50	6+47	- Both lanes - RANDOM CRACKING		60
18			6+50	TRANSVERSE CRACK	6	
19	7+00	7+23		LONGITUDINAL CRACK	23	
20	7+10	7+20		LONGITUDINAL CRACK	10	
21	7+55	7+72		LONGITUDINAL CRACK	17	
22	7+92	8+05		LONGITUDINAL CRACK	13	
23	8+18	8+26		LONGITUDINAL CRACK	8	
24			8+62	TRANSVERSE CRACK	2	

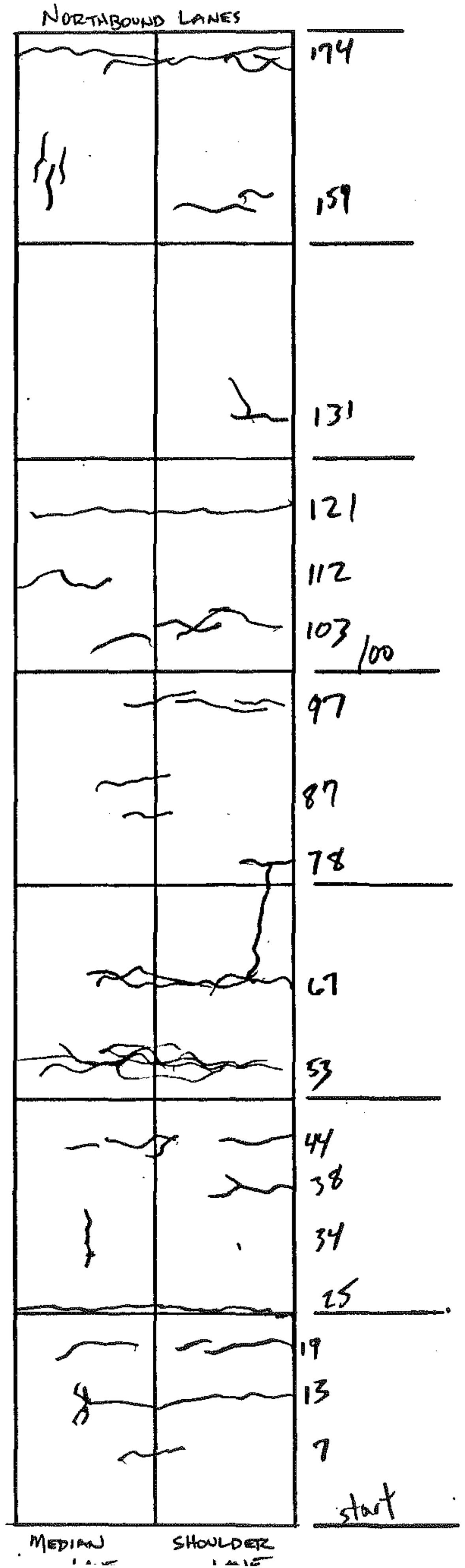
SECTION G-US23SB MP. 21 to 21 + 1000 FT To North
Greenup County

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
25	8+58	8+69		Longitudinal Crack	11	
26			9+22	Transverse Crack	2	

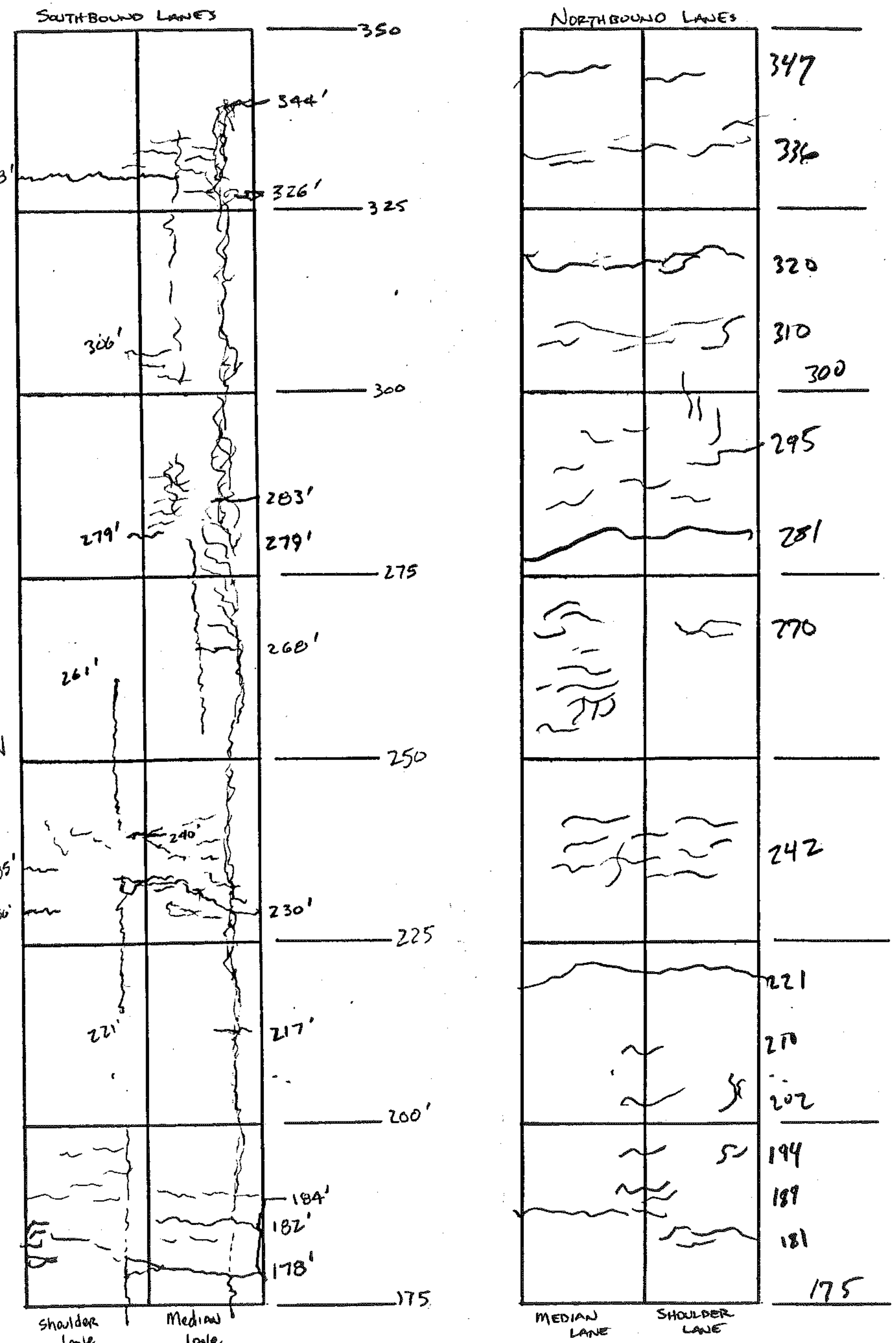
APPENDIX H

U.S. 23 GREENUP COUNTY
DESIGN SECTION H
Southbound LANES

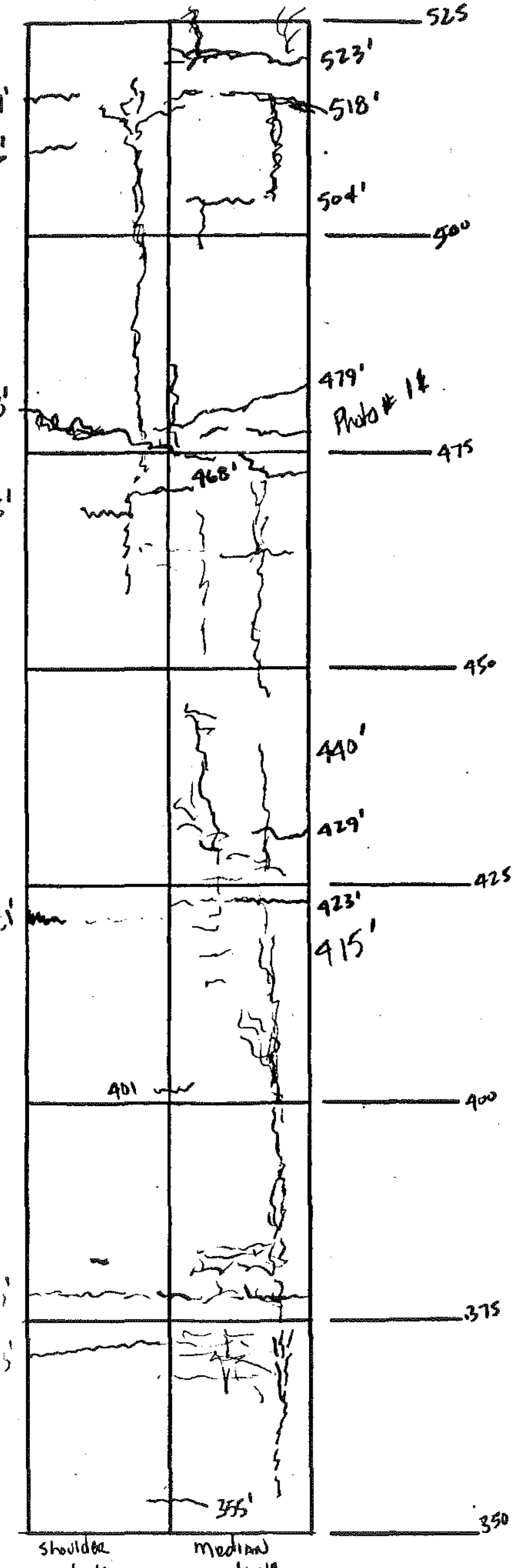




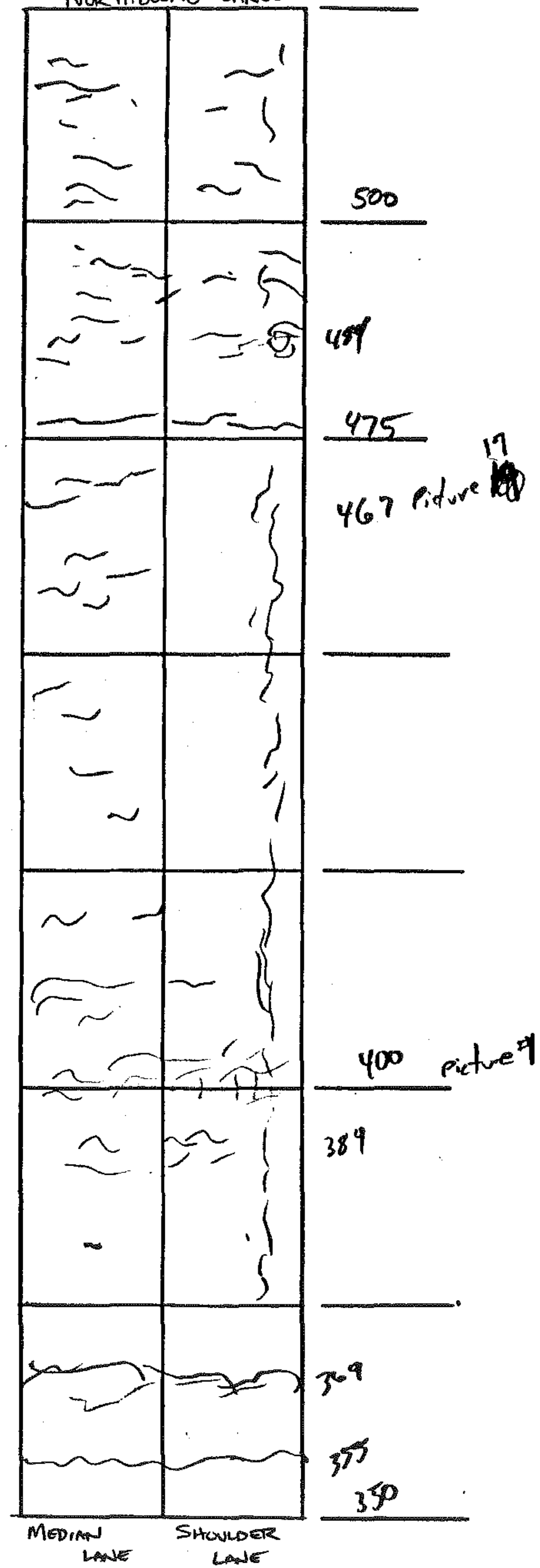
U.S. 23 GREENUP COUNTY
DESIGN SECTION H



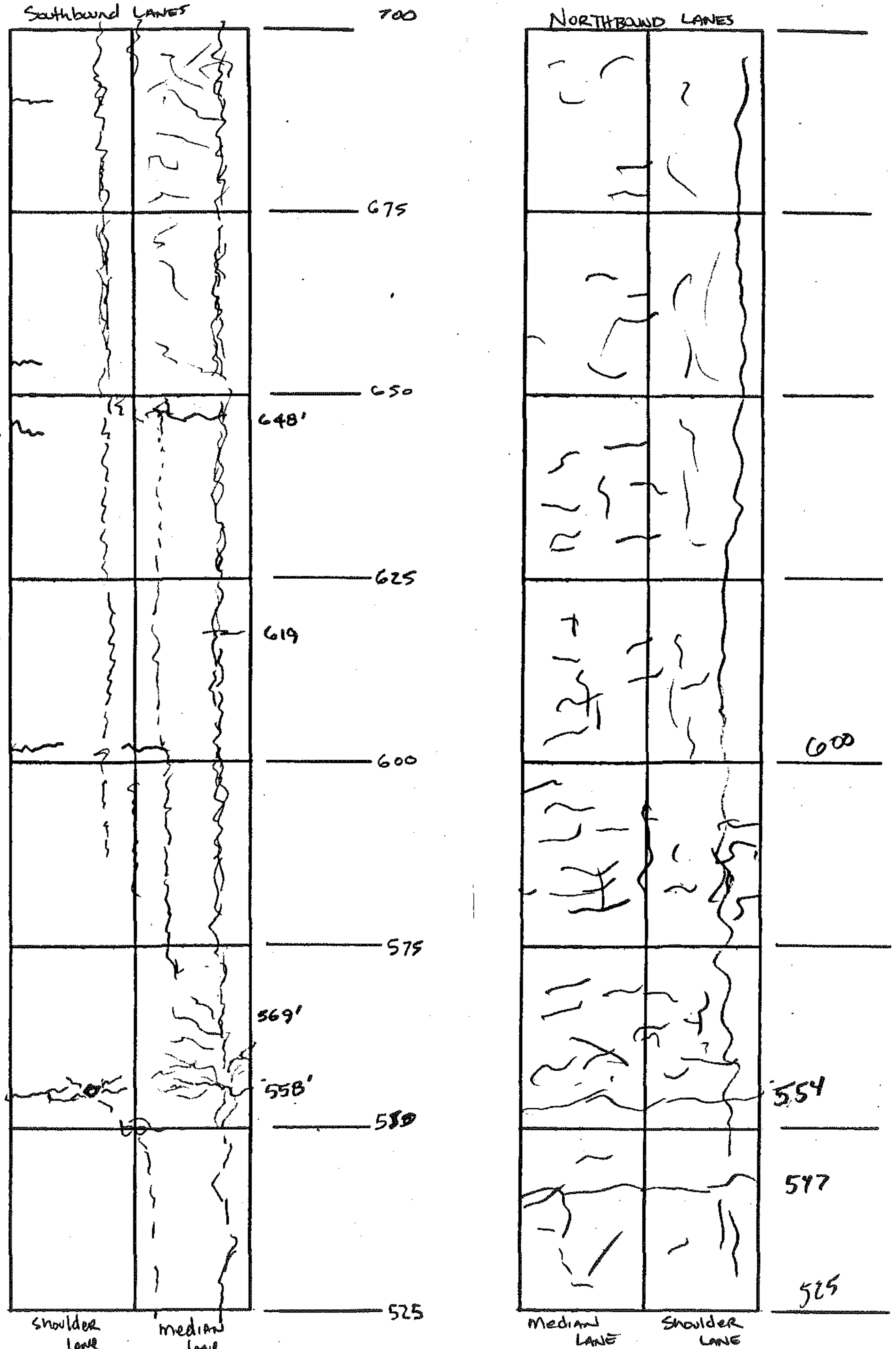
U.S. 23 Greenup County
Design Section H
Southbound Lanes



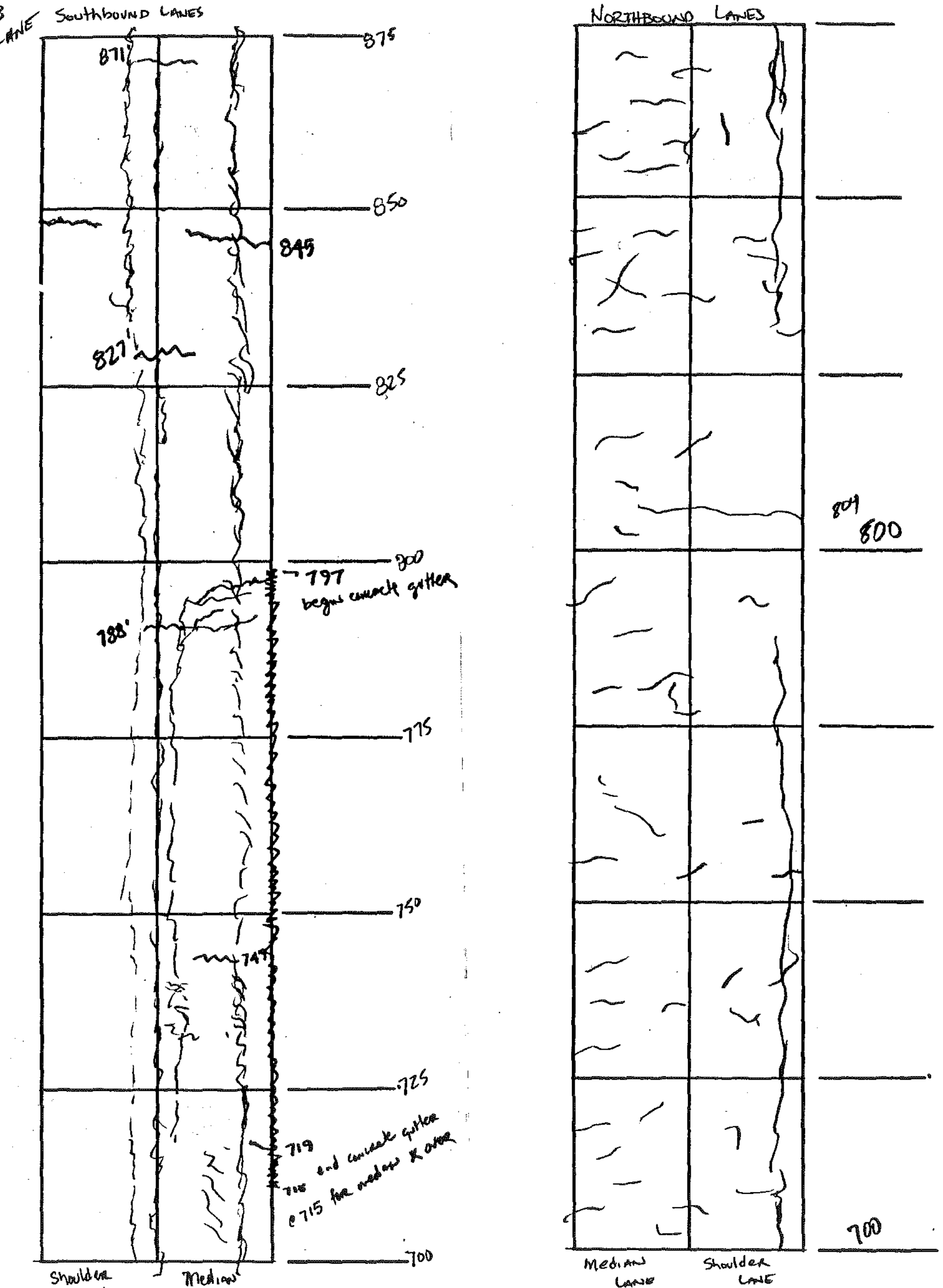
Northbound Lanes



U.S. 23 GREENUP COUNTY
DESIGN SECTION H

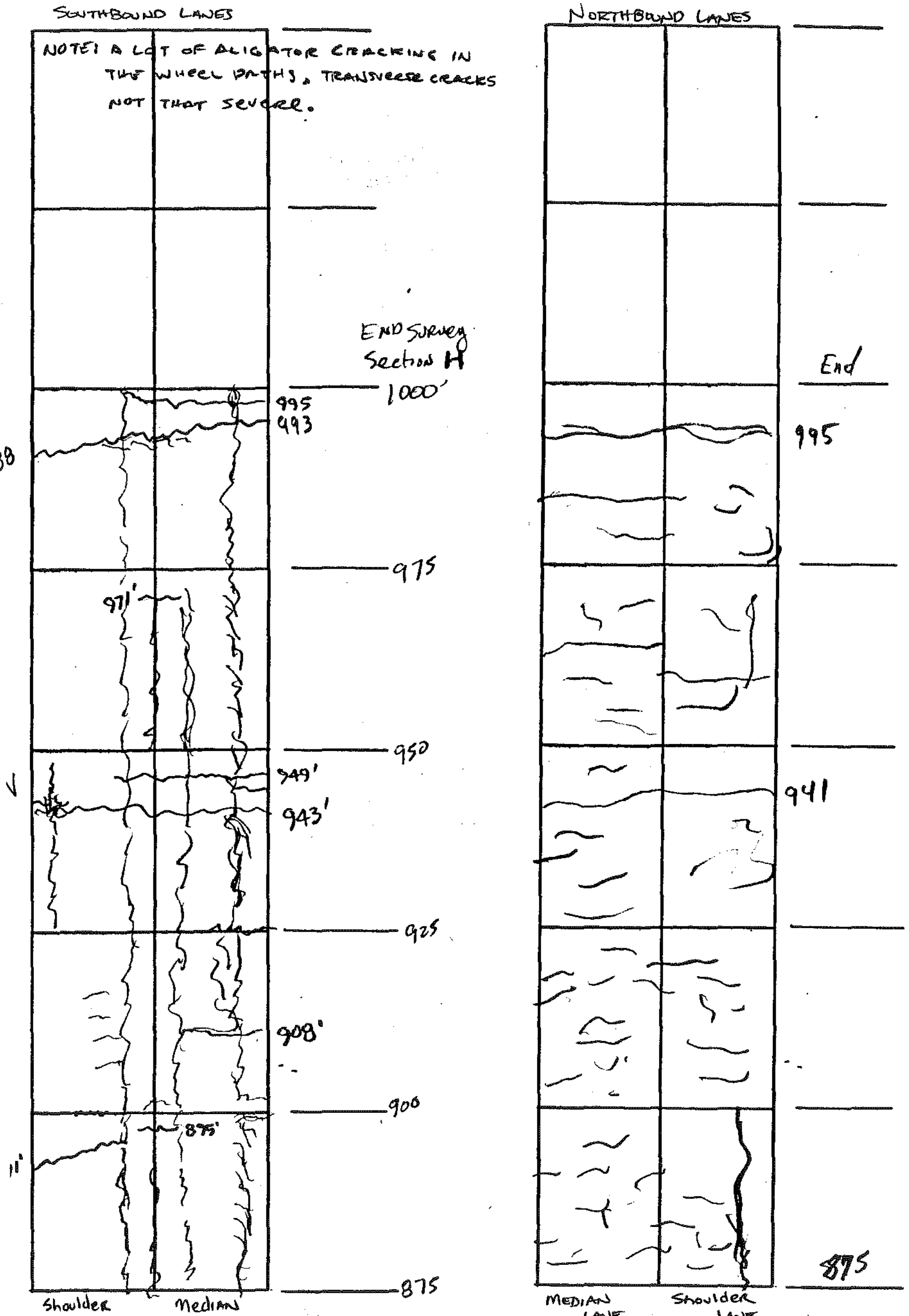


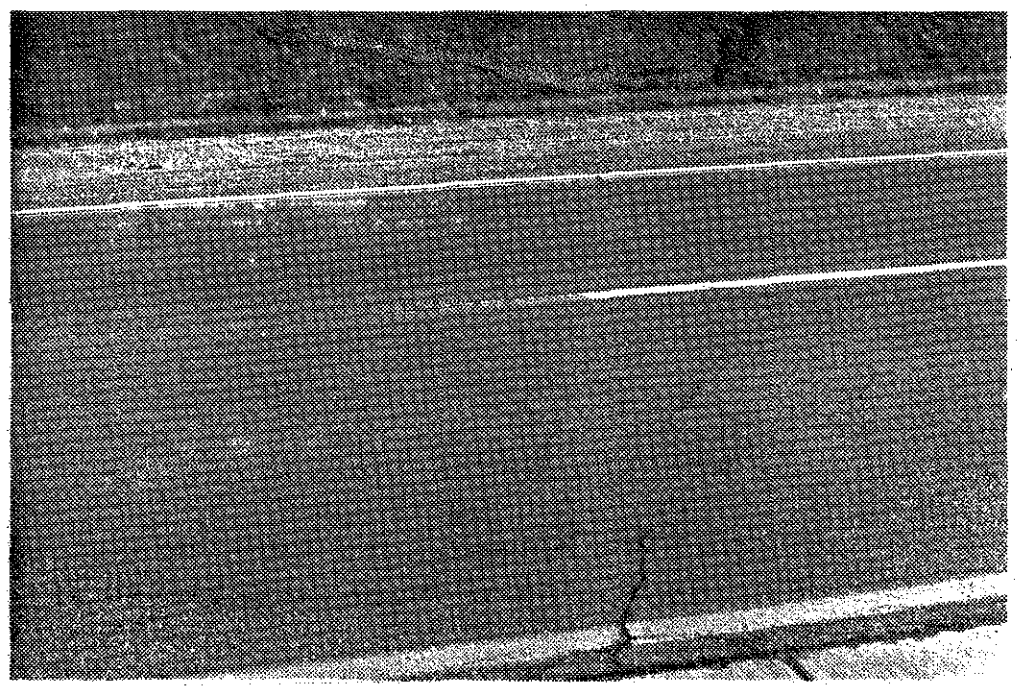
U.S. 23 GREENUP COUNTY
DESIGN SECTION H



U.S. 23 GREENUP COUNTY
DESIGN SECTION H

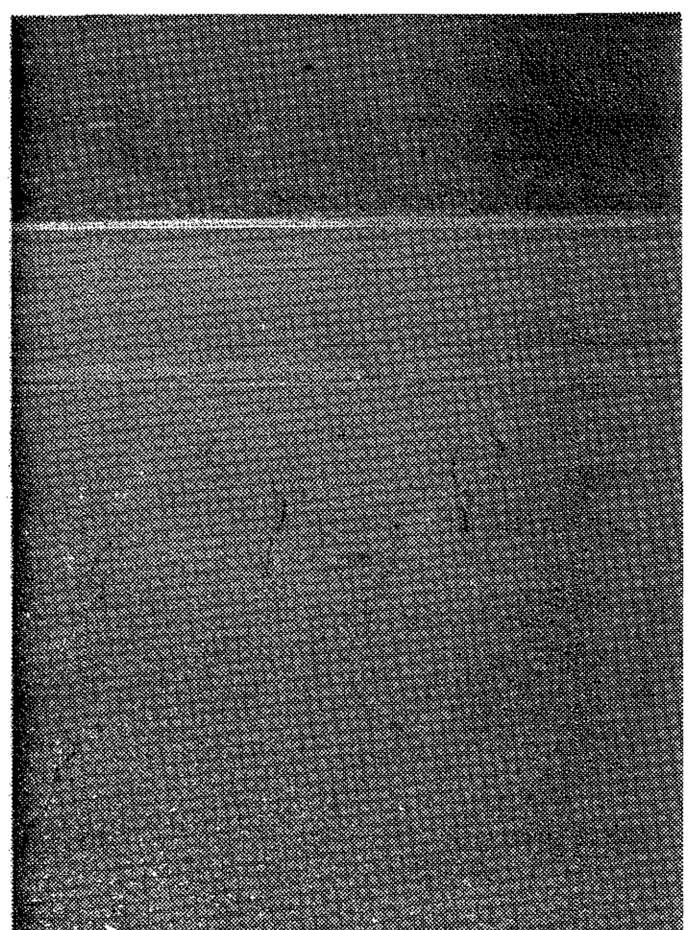
NOTE: A LOT OF ALIGATOR CRACKING IN THE WHEEL PATHS, TRANSVERSE CRACKS NOT THAT SEVERE.





Section H - SB lanes at 475 ft.

Section H - NB lanes at 400 ft.

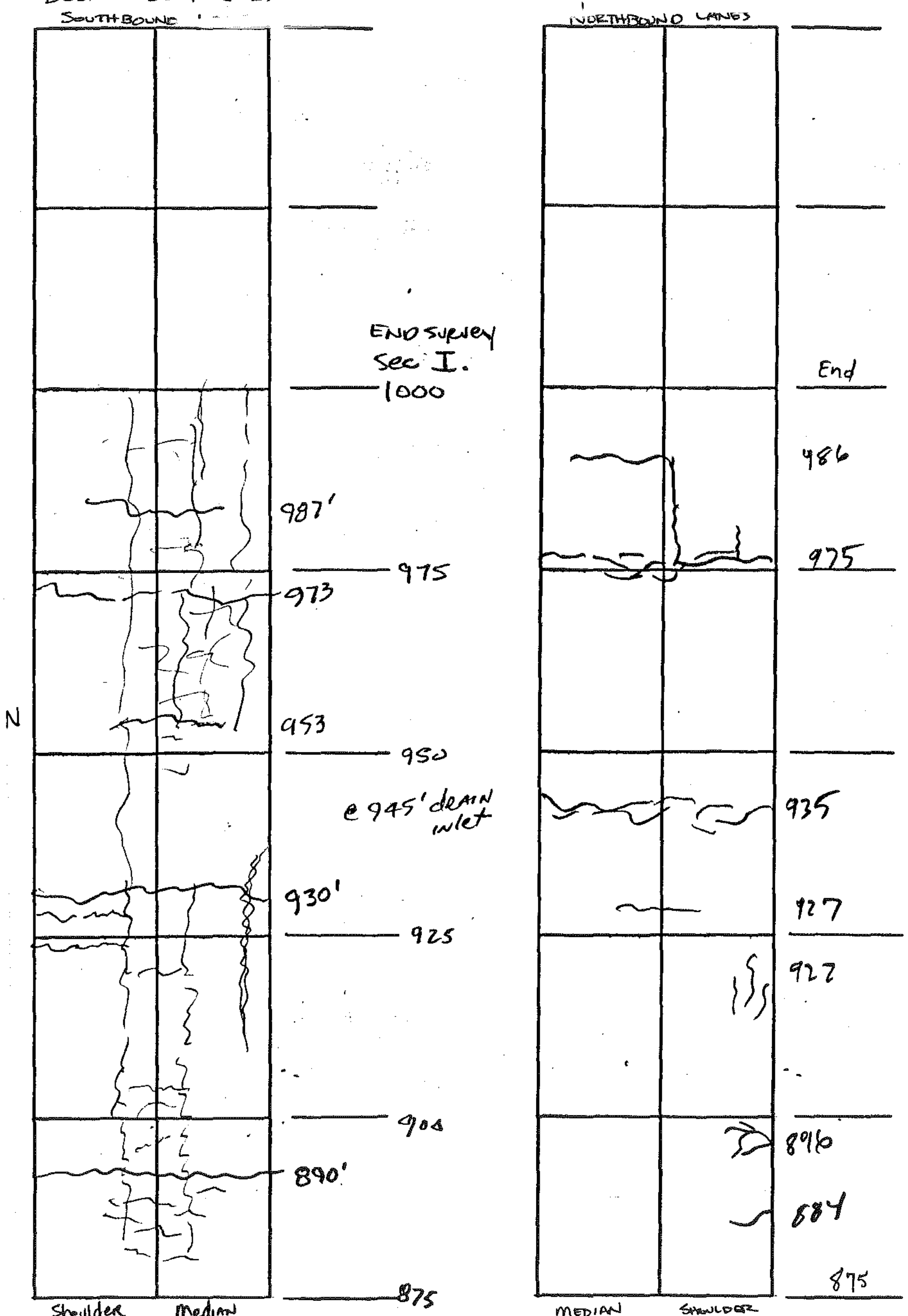


Section H - NB lanes at 467 ft.

SECTION H Northbound MP. 23.0 to 23.0 + 1000 ft.

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
1			0+07	transverse	5'	
2			0+13	"	18'	
3			0+19	"	14'	
4			0+25	"	24'	
5			0+34	longitudial	4'	
6			0+38	transverse	7'	
7			0+44	"	13'	
8			0+53	"	24'	
9			0+67	"	15'	
10	0+67	0+78		longitudial	11'	
11			0+87	transverse	4'@6'	
12			0+97	"	13'	
13			1+03	"	14'	
14			1+12	"	8'	
15			1+21	"	24'	
16			1+31	"	6'	
17			1+59	"	10'	
18			1+59	longitudial	8'	
19			1+74	transverse	24'	
20			1+81	"	12'	
21			1+89	"	15'	
22			1+94	"	6'	
23			2+02	"	8'	
24			2+10	"	4'	

U.S. 23 Greenup County
Design Section I



SECTION I Northbound MP. 26.0 to 26.0 + 1000 ft.

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
1	0+00	1+00		center line longitudial	100'	
2	0+00	4+25		longitudial	425'	
3			0+35	transverse	24'	
4			0+51	"	6'	
5			0+60	longitudial	6'	
6			0+71	transverse	24'	
7			0+85	"	4'	
8			1+10	"	6'	
9			1+10	Alligator		36'
10			1+31	transverse	8'	
11			1+56	Alligator		24'
12			1+99	transverse	10'	
13			2+33	"	12'	
14			2+66	"	12'	
15			2+68	Alligator		24'
16			2+93	transverse	6'	
17	3+16	3+20		Alligator		45'
18	3+25	3+45		Alligator		80'
19	3+55	3+65		"		30'
20	3+60	4+18		longitudial	58'	
21	3+75	3+90		Alligator		30'
22			4+18	transverse	8'	
23			4+21	"	4'	
24			4+43	"	4'	

SECTION I Northbound MP. 26.0 to 26.0 +1000 ft.

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
25			4+65	transverse	18'	
26			4+65	Alligator		8'
27	4+72	4+95		"		92'
28			5+25	longitudial	4'	
29			5+27	transverse	12'	
30	5+65	5+71		Alligator		24'
31			5+77	"		48'
32	5+82	6+18		longitudial	36'	
33			6+21			48'
34	6+25	6+75		longitudial	50'	
35	6+35	6+75		center line longitudial	40'	
36			6+30	Transverse	3'	
37			6+35	"	4'	
38			6+40	"	4'	
39			6+45	"	4'	
40			6+50	"	5'	
41			6+57	"	4'	
42			6+65	"	5'	
43			6+78	Alligator		48'
44			6+85	transverse	8'	
45			6+90	"	6'	
46			6+95	"	8'	
47	7+00	7+20		Alligator		40
48			7+05	transverse	4'	

SECTION I Northbound MP. 26.0 to 26.0 + 1000 ft.

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
49			7+10	transverse	6'	
50			7+15	"	6'	
51			7+20	"	5'	
52			7+30	"	4'	
53	7+35	7+42		longitudial	7'	
54			7+42	transverse	4'	
55			7+62	"	24'	
56			7+62	longitudial	6'	
57			7+74	transverse	6' @ 6'	
58	7+88	8+17		longitudial	29'	
59			8+02	transverse	6'	
60			8+05	"	5'	
61			8+11	"	4'	
62			8+17	"	12'	
63	8+25	8+50		longitudial	25'	
64			8+33	Alligator		16'
65	8+56	8+60		"		96'
66			8+84	transverse	4'	
67			8+96	Alligator		6'
68	9+20	9+23		longitudial	4' @ 5'	
69			9+27	transverse	7'	
70			9+35	"	24'	
71			9+75	"	24'	
72	9+75	9+86		longitudial	11'	
73			9+86	transverse	7'	

End

SECTION H Northbound MP. 23.0 to 23.0 + 1000 ft.

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
25			2+21	transverse	24'	
26			2+42	Alligator		90' sq
27	2+60	2+70		"		100'
28			2+70	transverse	6'	
29			2+81	"	24'	
30	2+88	2+98		Alligator		100'
31			3+10	transverse	24'	
32			3+20	"	24'	
33			3+36	"	24'	
34			3+47	"	14'	
35			3+55	"	24'	
36			3+69	"	24'	
37	3+75	4+75		longitudial	100'	
38			3+89	Alligator		18'
39			4+00	"		40'
40			4+10	transverse	10'	
41			4+20	"	6'	
42			4+30	"	2'	
43			4+36	"	4'	
44			4+40	"	4'	
45			4+56	Alligator		16'
46			4+67	transverse	10'	
47	4+84	4+95		Alligator		220'
48	5+00	5+20		"		360'

SECTION H Northbound MP. 23.0 to 23.0 + 1000 ft.

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
49	5+33	5+47		longitudial	14 @ 6'	
50			5+47	transverse	24'	
51			5+54	"	24'	
52	5+54	7+85		longitudial	231'	
53	5+54	5+69		Alligator		180'
54	6+00	6+20		"		200'
55	6+30	6+42		"		96'
56	6+50	6+65		"		75'
57			6+77	transverse	4'	
58			6+81	"	4'	
59	7+00	7+20		Alligator		140'
60	7+30	7+40		"		70'
61			7+55	transverse	8'	
62			7+62	"	6'	
63			7+80	"	6'	
64			7+65	"	8'	
65			8+04	"	16'	
66			8+22	"	10'	
67			8+30	"	6'	
68	8+35	9+00		longitudial	65'	
69	8+40	8+48		Alligator		40'
70	8+55	8+65		"		50'
71	8+75	8+90		"		150
72	9+00	9+20		"		400

SECTION H Northbound MP. 230 to 230 + 1000 ft.

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
73			9+27	transverse	5'	
74			9+32	"	8'	
75			9+38	"	5'	
76			9+41	"	24'	
77			9+59	"	6'	
78			9+62	"	12'	
79			9+66	"	12'	
80	9+62	9+70		longitudial	8'	
81			9+80	transverse	8'	
82			9+86	"	14'	
83			9+95	"	24'	
				End		

SECTION H - US23SB MP. 23 to 23 + 1000 FT TO NORTH.
GREENUP COUNTY

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
1	0+00	1+00		ALIGATOR		1000
2			0+03	RANDOM TRANSVERSE	7	
3			0+53	TRANSVERSE CRACK	3	
4	0+77	1+35		LONGITUDINAL CRACK	58	
5			0+98	RANDOM TRANSVERSE	12	
6			1+05	TRANSVERSE CRACK	3	
7			1+40	RANDOM TRANSVERSE		8
8			1+46	TRANSVERSE CRACK	12	
9	1+46	1+61		RANDOM LONGITUDINAL	15	
10	1+65	2+00		LONGITUDINAL CRACK	35	
11	1+67	2+00		LONGITUDINAL CRACK	33	
12			1+78	TRANSVERSE CRACK	14	
13			1+80	RANDOM TRANSVERSE		18
14			1+82	TRANSVERSE CRACK	12	
15			1+84	TRANSVERSE CRACK	12	
16	1+84	1+95		RANDOM TRANSVERSE		50
17	1+78	1+84		LONGITUDINAL CRACK	6	
18	2+00	3+34		ALIGATOR CRACKING		335
19			2+17	TRANSVERSE CRACK	3	
20	2+21	2+34		LONGITUDINAL CRACK	13	
21			2+29	RANDOM TRANSVERSE	8	
22			2+30	TRANSVERSE / ALIGATOR	14	8
23			2+30	TRANSVERSE CRACK	3	
24			2+35	TRANSVERSE CRACK	3	

SECTION H - US23SB MP. 23 to 23 + 1000 FT to NORTH
Greenup County

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
25			2+40	TRANSVERSE CRACK	4	
26	2+30	2+40		RANDOM TRANSVERSE		50
27	2+37	2+42		RANDOM CRACKING		25
28	2+40	2+61		LONGITUDINAL CRACK	21	
29	2+56	2+79		LONGITUDINAL CRACK	23	
30			2+68	TRANSVERSE CRACK	4	
31			2+79	TRANSVERSE CRACK	3	
32			2+83	TRANSVERSE CRACK	5	
33	2+80	2+86		ALLIGATOR CRACKING		15
34			3+06	TRANSVERSE CRACK	4	
35	3+03	3+40		LONGITUDINAL CRACK	37	
36			3+26	TRANSVERSE CRACK	3	
37			3+28	TRANSVERSE CRACK	16	
38	3+26	3+44		RANDOM CRACKS		90
39			3+55	TRANSVERSE CRACK	5	
40	3+70	3+75		RANDOM CRACKING		50
41			3+73	TRANSVERSE CRACK	12	
42	3+55	4+15		ALLIGATOR CRACKING		150
43			3+78	TRANSVERSE CRACK	24	
44	3+78	3+84		RANDOM CRACKS		48
45			4+01	TRANSVERSE CRACK	4	
46			4+21	TRANSVERSE CRACK	12	
47			4+23	TRANSVERSE CRACK	12	
48	4+15	4+45		RANDOM / ALLIGATOR		75

SECTION H-US23SB MP. 23 to 23 + 1000FT TO NORTH
GREENUP COUNTY

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
49			4+29	TRANSVERSE CRACK	5	
50	4+27	4+40		LONGITUDINAL CRACK	13	
51	4+48	4+23		LONGITUDINAL CRACK	25	
52	4+52	4+68		LONGITUDINAL CRACK	16	
53			4+60	TRANSVERSE CRACK	6	
54			4+65	TRANSVERSE CRACK	4	
55			4+68	TRANSVERSE CRACK	4	
56	4+73	4+78		RANDOM TRANSVERSE	24	
57			4+76	ALIGATOR CRACKING		8
58			4+79	TRANSVERSE CRACKIN	13	
59	4+60	5+00		LONGITUDINAL CRACK	40	
60	5+00	5+04		LONGITUDINAL CRACK	4	
61			5+04	TRANSVERSE CRACK	6	
62	5+04	5+18		ALIGATOR CRACKING		35
63	5+12	5+17		ALIGATOR CRACKING		30
64			5+12	TRANSVERSE CRACK	4	
65			5+17	TRANSVERSE CRACK	4	
66			5+18	TRANSVERSE CRACK	12	
67			5+23	TRANSVERSE CRACK		
68	5+23	5+25		ALIGATOR CRACKING		5
69	5+23	5+25		ALIGATOR CRACKING		5
70	5+25	5+50		LONGITUDINAL CRACK	25	
71	5+25	5+50		LONGITUDINAL CRACK	25	
72			5+50	TRANSVERSE/ALIGATOR	4	4

SECTION H - US23SB MP. 23 to 23 + 1000 FT TO NORTH
GREENUP COUNTY

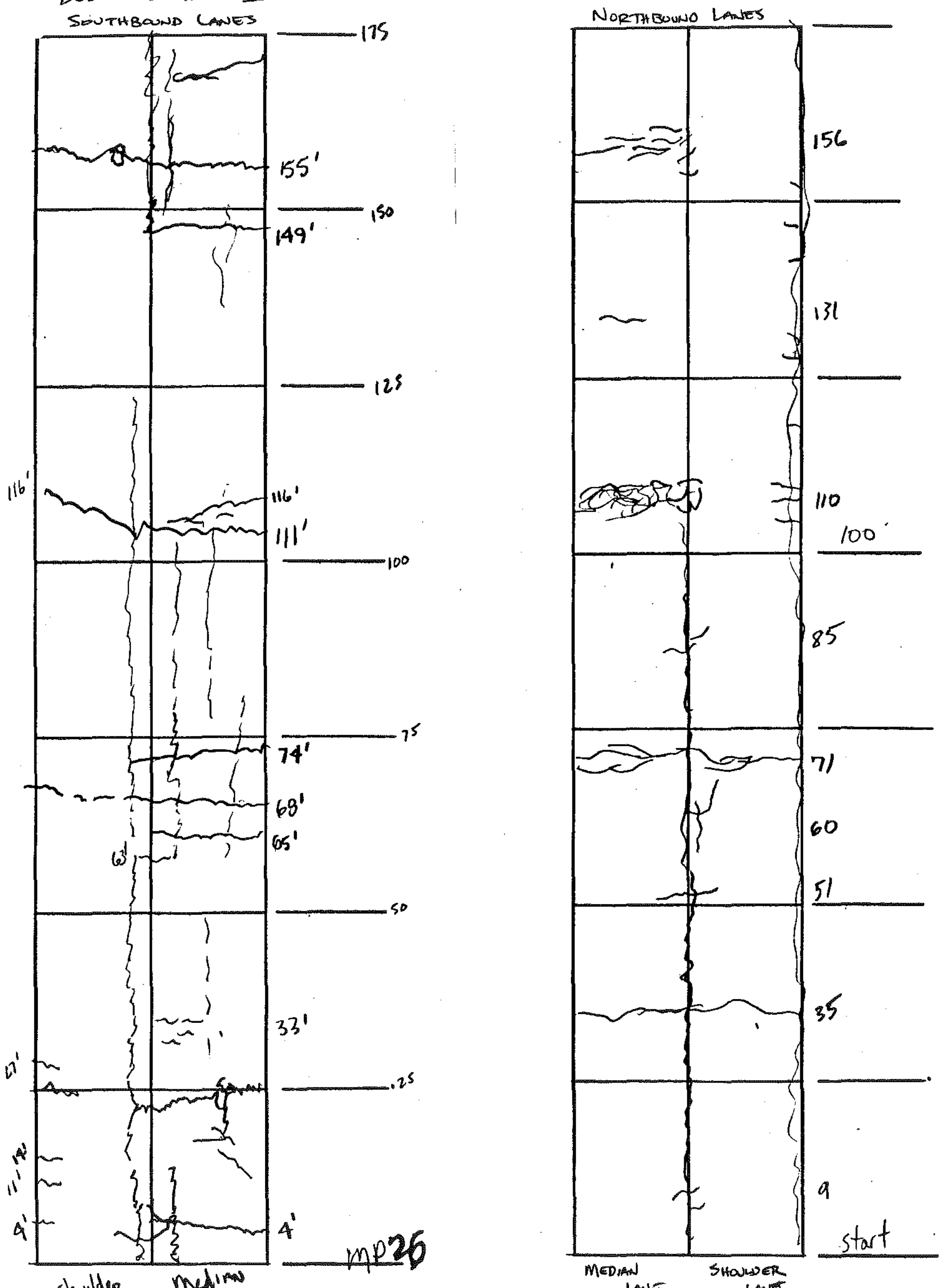
DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
73			5+55	RANDOM TRANSVERSE	12	24
74	5+50	10+00		ALIGATOR CRACKING		1125
75	5+58	5+69		RANDOM CRACKING		55
76	5+70	6+48		LONGITUDINAL CRACKING	78	
77	5+85	6+48		LONGITUDINAL CRACK	63	
78			6+02	TRANSVERSE CRACKING	11	
79			6+19	TRANSVERSE CRACKING	4	
80			6+42	TRANSVERSE CRACKING	3	
81			6+48	TRANSVERSE CRACKING	8	
82			6+53	TRANSVERSE CRACKING	3	
83	6+50	7+00		ALIGATOR CRACKING		125
84			6+86	TRANSVERSE CRACK	4	
85	6+60	7+00		RANDOM CRACKING		200
86	6+90	8+25		LONGITUDINAL CRACK	135	
87	7+00	9+90		ALIGATOR CRACKING		725
88	7+05	7+20		RANDOM CRACKING		60
89	7+20	7+88		LONGITUDINAL CRACK	68	
90	7+15	7+18		ALLIGATOR CRACK		8
91			7+47	TRANSVERSE CRACK	5	
92	7+88	7+97		RANDOM CRACKING		90
93	7+15	7+97		LONGITUDINAL CRACK	82	
94			7+88	TRANSVERSE CRACK	12	
95			8+27	TRANSVERSE CRACK	6	
96			8+45	TRANSVERSE CRACK	14	

SECTION H-US23SB MP. 23 to 23 + 1000 FT To NORTH
Greenup County

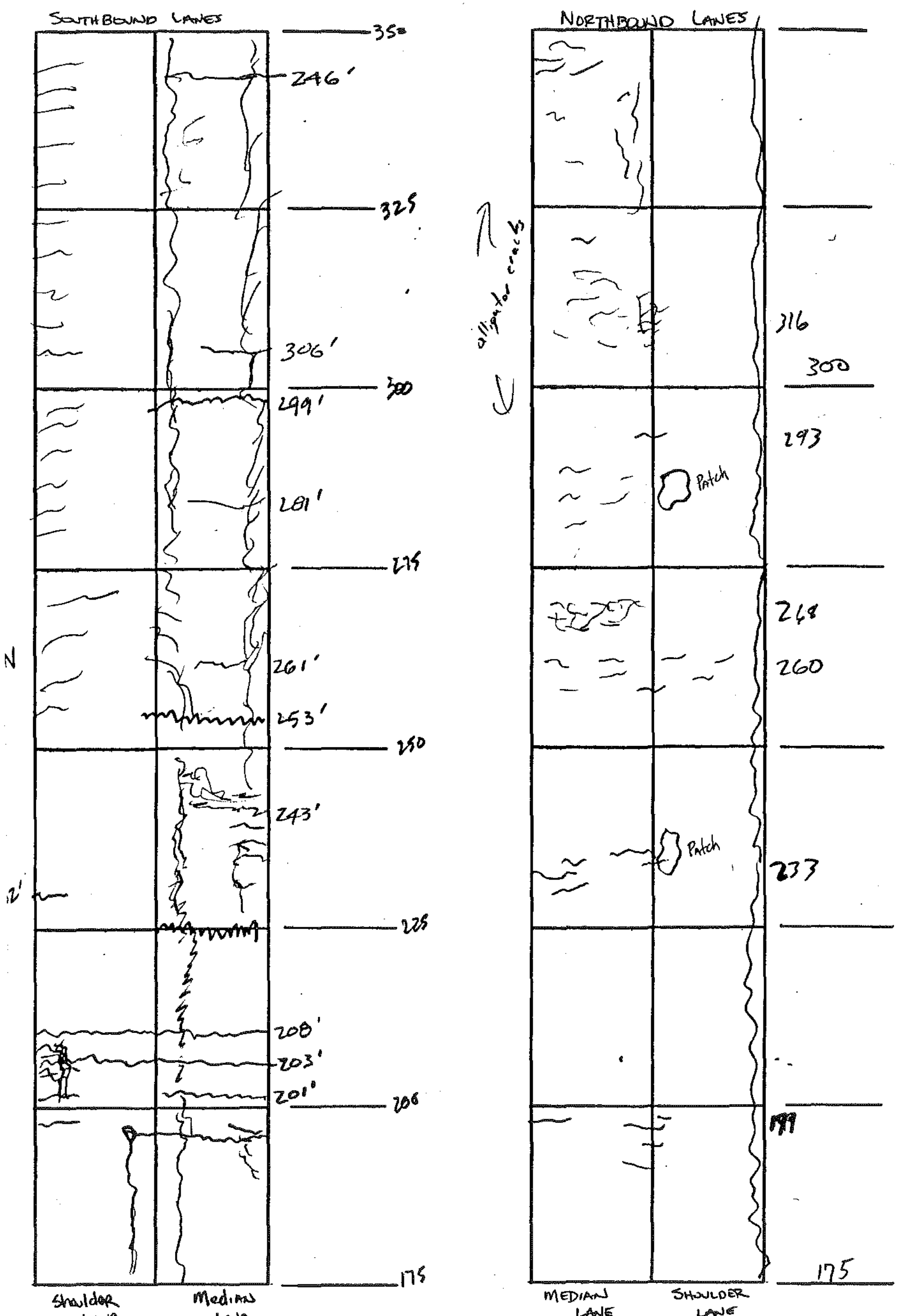
DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
97			8+71	TRANSVERSE CRACK	8	
98	8+50	8+95		LONGITUDINAL CRACK	45	
99			8+91	TRANSVERSE CRACK	10	
100			8+95	TRANSVERSE CRACK	4	
101			9+00	TRANSVERSE CRACK	8	
102			9+08	TRANSVERSE CRACK	10	
103			9+25	TRANSVERSE CRACK	8	
104	9+25	9+50		ALIGATOR CRACK		63
105			9+43	TRANSVERSE CRACK	24	
106			9+49	TRANSVERSE CRACK	16	
107	9+50	9+71		LONGITUDINAL CRACK	21	
108	8+75	9+71		ALIGATOR CRACKING		240
109			9+71	TRANSVERSE CRACK	4	
110	9+88	9+93		RANDOM TRANSVERSE	24	
111			9+95	TRANSVERSE CRACK	16	
112	9+89	10+00		LONGITUDINAL CRACK	11	

APPENDIX I

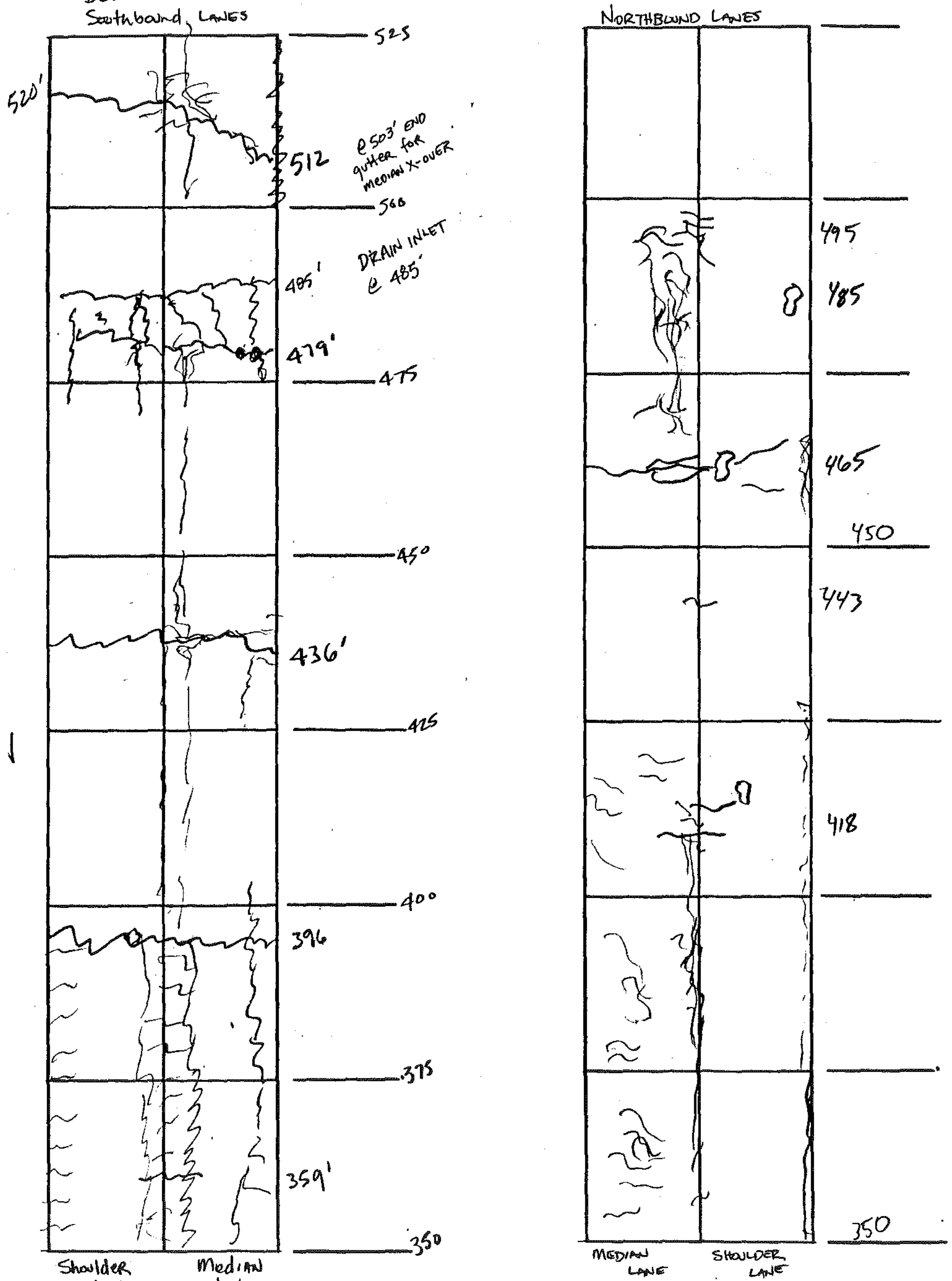
U.S. 23 GREENUP COUNTY
DESIGN SECTION I



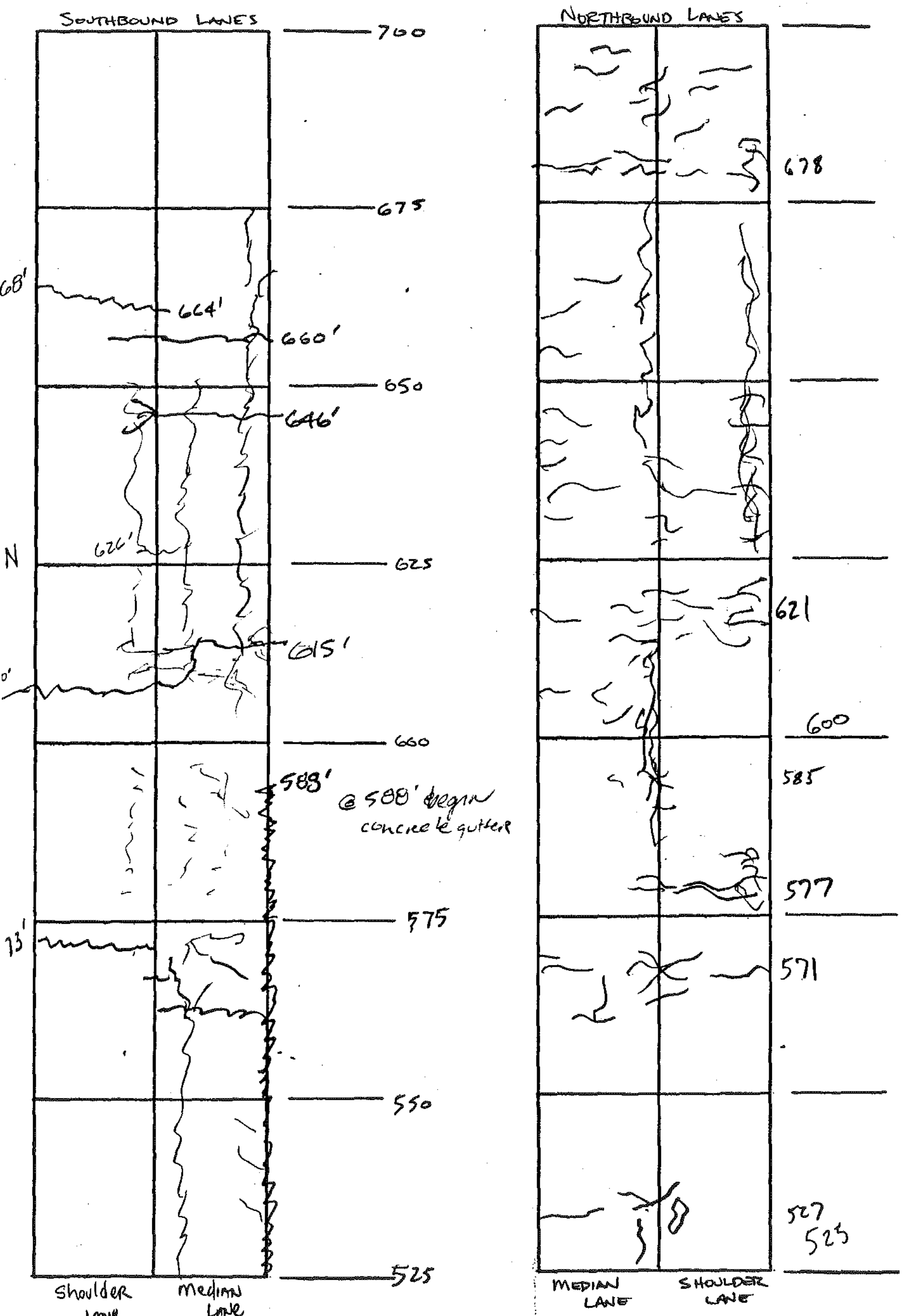
U.S. 23 GREENUP County
DESIGN SECTION I



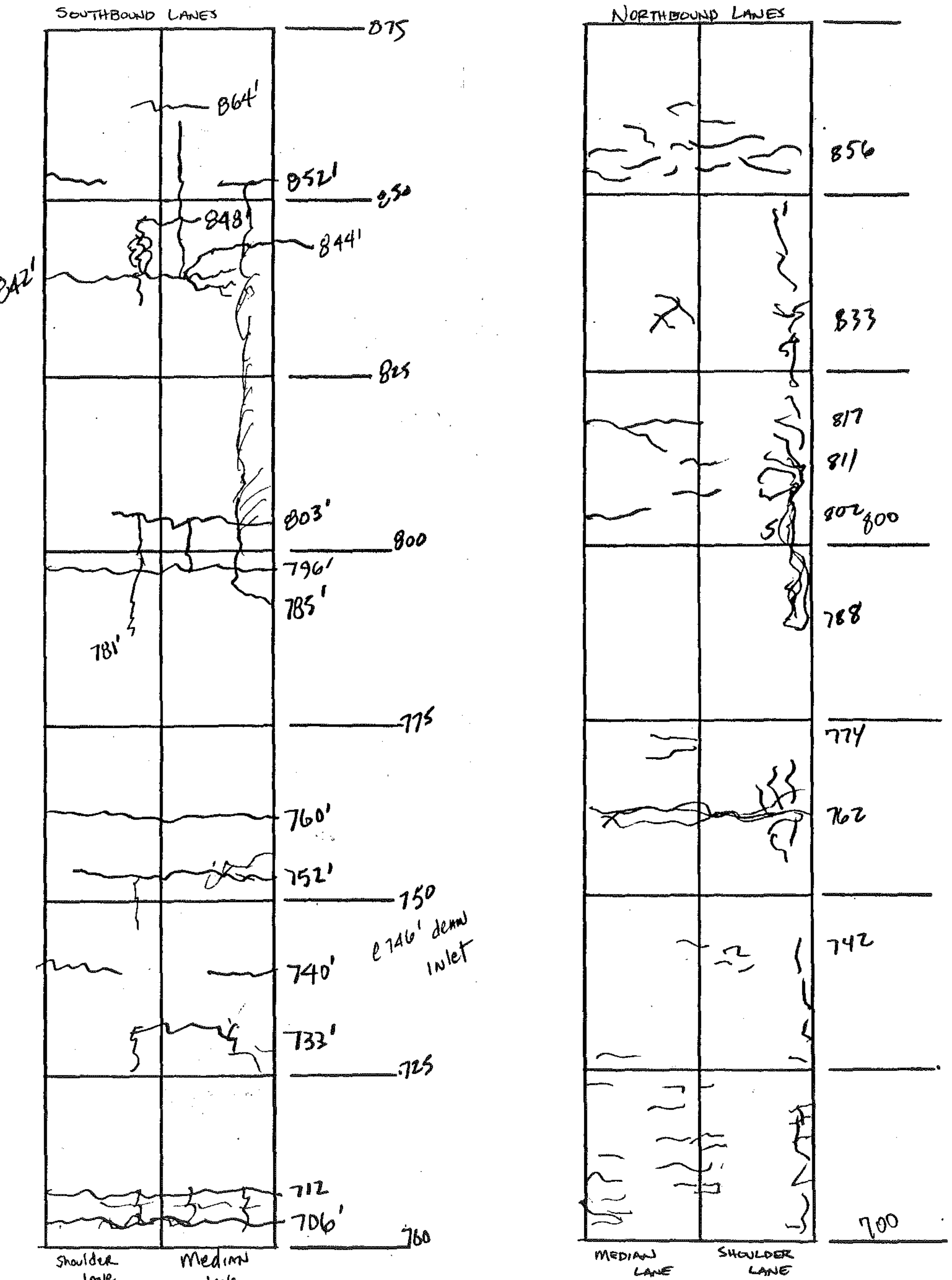
U.S. 23 Greenup County
Design Section I
Southbound Lanes



U.S. 23 GREENUP COUNTY
DESIGN SECTION I



U.S. 23 GREENUP COUNTY
DESIGN SECTION I



SECTION I - U.S. 23 SB MP. 26 to 26 + 1000 FT TO NORTH.
GREENUP County

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
1			0+04	TRANSVERSE CRACK	16	
2	0+00	0+14		LONGITUDINAL CRACK	14	
3	0+00	0+14		LONGITUDINAL CRACK	14	
4			0+04	TRANSVERSE CRACK	2	
5			0+11	TRANSVERSE CRACK	3	
6			0+14	TRANSVERSE CRACK	3	
7	0+18	0+22		RANDOM CRACKING		24
8			0+25	TRANSVERSE CRACK	15	
9	0+14	1+25		LONGITUDINAL CRACK	111	
10			0+25	TRANSVERSE CRACK	5	
11			0+27	TRANSVERSE CRACK	3	
12			0+33	RANDOM CRACKING		24
13	0+30	0+50		LONGITUDINAL CRACK	20	
14			0+63	TRANSVERSE CRACK	4	
15			0+65	TRANSVERSE CRACK	12	
16	0+63	0+81		LONGITUDINAL CRACK	18	
17	0+63	1+05		LONGITUDINAL CRACK	42	
18			0+68	TRANSVERSE CRACK	24	
19			0+74	TRANSVERSE CRACK	15	
20	0+80	1+11		LONGITUDINAL CRACK	31	
21	1+11	1+16		RANDOM TRANSVERSE	24	
22			1+16	TRANSVERSE CRACK	11	
23			1+49	TRANSVERSE CRACK	12	
24	1+49	1+75		LONGITUDINAL CRACK	26	

SECTION I - US23SB MP. 26 to 26 + 1000 FT. TO NORTH
GREENUP COUNTY

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
25	1+50	1+73		LONGITUDINAL CRACK	23	
26			1+55	TRANSVERSE CRACK	24	
27			1+70	TRANSVERSE CRACK	10	
28	1+75	4+65		ALIGATOR CRACKING		725
29	1+76	1+90		LONGITUDINAL CRACK	14	
30			1+90	TRANSVERSE CRACK	16	
31			1+95	TRANSVERSE CRACK		
32			2+01	TRANSVERSE CRACK	12	
33			2+03	TRANSVERSE CRACK	24	
34	2+01	2+08		ALIGATOR CRACKING		21
35			2+08	TRANSVERSE CRACKING	24	
36			2+25	TRANSVERSE/ALIGATOR	12	12
37	2+27	4+05		ALIGATOR (EDGE)		448
38	2+43	2+48		RANDOM TRANSVERSE		50
39			2+32	TRANSVERSE CRACK	3	
40			2+53	TRANSVERSE/ALIGATOR	13	13
41			2+53	TRANSVERSE CRACK	3	
42			2+58	TRANSVERSE CRACK	4	
43			2+63	TRANSVERSE CRACK	5	
44			2+68	TRANSVERSE CRACK	7	
45			2+78	TRANSVERSE CRACK	3	
46			2+81	TRANSVERSE CRACK	8	
47			2+81	TRANSVERSE CRACK	3	
48			2+84	TRANSVERSE CRACK	3	

SECTION I - US23SB MP. 26 to 26 + 1000 FT To North
GREENUP County

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
49			2+88	TRANSVERSE CRACK	4	
50			2+92	TRANSVERSE CRACK	4	
51			2+96	TRANSVERSE CRACK	4	
52			2+99	TRANSVERSE CRACK	13	
53			3+06	TRANSVERSE CRACK	7	
54			3+06	TRANSVERSE CRACK	4	
55			3+09	TRANSVERSE CRACK	3	
56			3+13	TRANSVERSE CRACK	4	
57			3+18	TRANSVERSE CRACK	4	
58			3+23	TRANSVERSE CRACK	4	
59			3+28	TRANSVERSE CRACK	3	
60			3+33	TRANSVERSE CRACK	4	
61			3+37	TRANSVERSE CRACK	5	
62			3+40	TRANSVERSE CRACK	5	
63			3+46	TRANSVERSE CRACK	6	
64			3+46	TRANSVERSE CRACK	11	
65	3+51	3+96		ALIGATOR CRACKING		115
66			3+55	TRANSVERSE CRACK	3	
67			3+59	TRANSVERSE CRACK	3	
68			3+63	TRANSVERSE CRACK	3	
69			3+67	TRANSVERSE CRACK	3	
70			3+71	TRANSVERSE CRACK	4	
71			3+75	TRANSVERSE CRACK	3	
72			3+79	TRANSVERSE CRACK	3	

SECTION I - US23SB MP. 26 to 26 + 1000 FT to North

Greenup County

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
73			3+84	Transverse Crack	3	
74			3+89	Transverse Crack	3	
75			3+96	Transverse Crack	3	
76	3+96	4+36		Longitudinal Crack	40	
77	4+25	4+36		Longitudinal Crack	11	
78			4+36	Transverse/Aligator	24	24
79	4+72	4+83		Longitudinal Crack	11	
80	4+70	4+85		Aligator Cracking		38
81	4+71	4+85		Aligator Cracking		35
82	4+75	4+86		Longitudinal Crack	11	
83	4+79	4+85		Longitudinal Crack	6	
84			4+85	Transverse Crack	24	
85	5+05	5+70		Aligator Cracking		163
86	5+12	5+20		Random Transverse	24	
87	5+00	5+88		Longitudinal/Ravelling	88	
88			5+32	Random Transverse	3	
89			5+38	Random Transverse	3	
90			5+45	Random Transverse	2	
91			5+62	Transverse Crack	12	
92			5+73	Transverse Crack	12	
93	5+67	5+74		Random Cracking		60
94	5+80	5+90		Longitudinal Crack	10	
95	5+80	5+90		Random Cracking		50
96	6+10	6+15		Random Transverse	24	

SECTION I - US23SB MP. 26 to 26 + 1000 FT To North

Greenup County

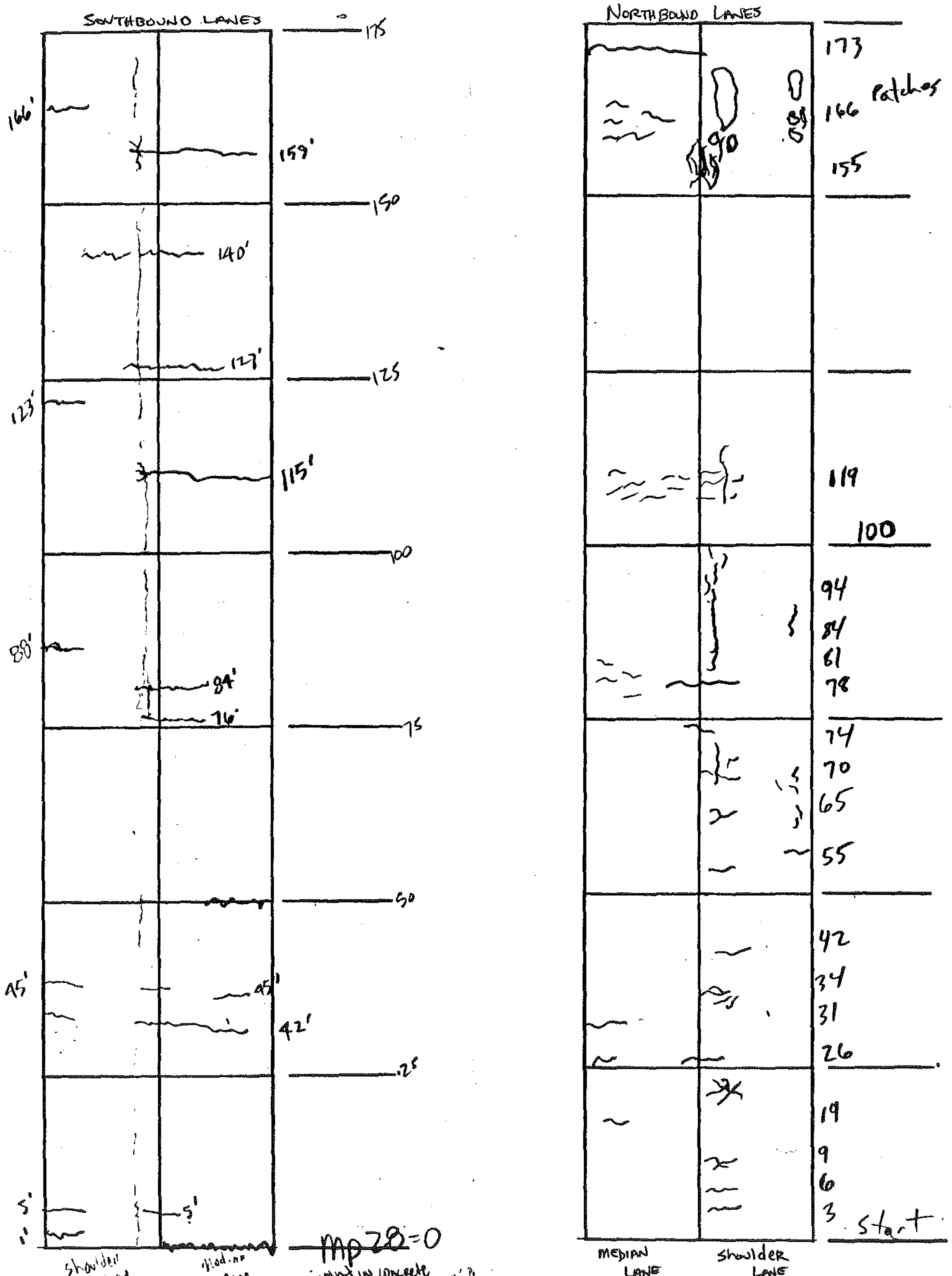
DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
97	6+05	6+75		Aligator Cracking		175
98	6+10	6+51		Aligator Cracking		103
99	6+15	6+50		Longitudinal Crack	35	
100			6+26	Transverse Crack	5	
101	6+42	6+48		Aligator Cracking		15
102			6+46	Transverse Crack	14	
103			6+60	Transverse Crack	17	
104	6+64	6+68		Transverse Crack	13	
105			7+06	Transverse/Aligator	24	12
106	7+06	7+12		Longitudinal Crack	6	
107	7+06	7+12		Longitudinal Crack	6	
108	7+06	7+12		Longitudinal Crack	6	
109			7+12	Transverse Crack	24	
110	7+26	7+34		Longitudinal Crack	8	
111			7+33	Transverse Crack	12	
112			7+40	Transverse Crack	16	
113	7+45	7+52		Longitudinal Crack	7	
114			7+52	Transverse Crack	21	
115			7+60	Transverse Crack	24	
116	7+81	8+03		Longitudinal Crack	22	
117			7+85	Transverse Crack	6	
118			7+96	Transverse Crack	24	
119	7+96	8+52		Aligator Cracking		140
120	7+96	8+03		Longitudinal Crack	7	

SECTION I - U.S. 23SB MP. 26 to 26 + 1000 FT To North
Greenup County

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
121			8+03	Transverse Crack	17	
122			8+42	Transverse Crack	20	
123	8+42	8+48		Aligator Cracking		15
124			8+44	Transverse Crack	12	
125			8+48	Transverse Crack	8	
126	8+44	8+62		Longitudinal Crack	18	
127			8+52	Transverse Cracks	12	
128			8+64	Transverse Crack	8	
129	8+80	9+30		Aligator Cracking		125
130	8+80	9+30		Aligator Cracking		125
131			8+90	Transverse Crack	24	
132			9+24	Transverse Crack	9	
133	9+10	9+40		Aligator Cracking		75
134			9+27	Transverse Crack	9	
135			9+30	Transverse Crack	24	
136	9+30	10+00		Aligator Cracking		175
137			9+53	Transverse Crack	12	
138	9+53	10+00		Aligator Cracking		118
139	9+53	10+00		Aligator Cracking		118
140			9+73	Transverse Crack	24	
141			9+87	Transverse Crack	14	

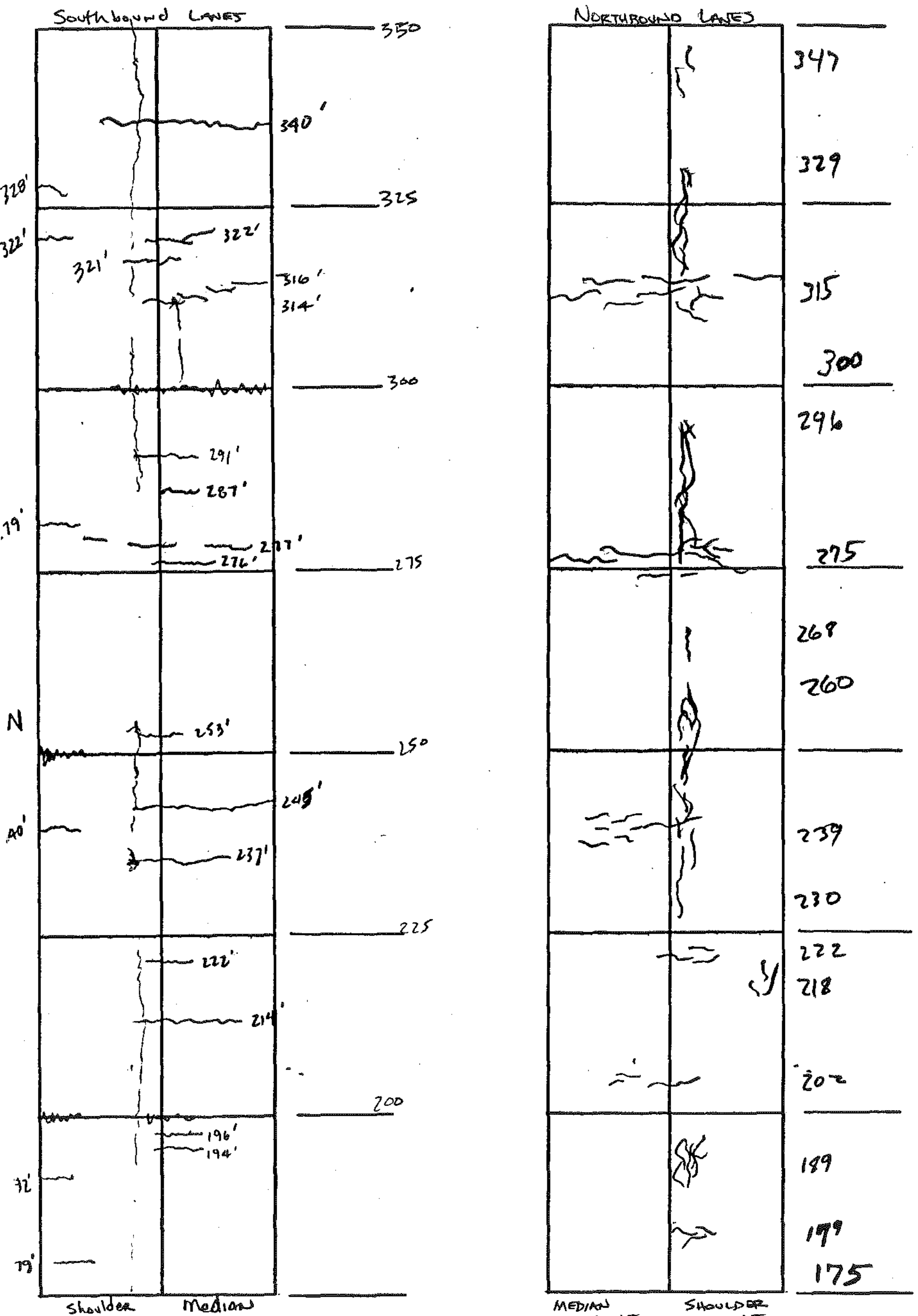
APPENDIX J

U.S. 23 GREENUP COUNTY
DESIGN SECTION J

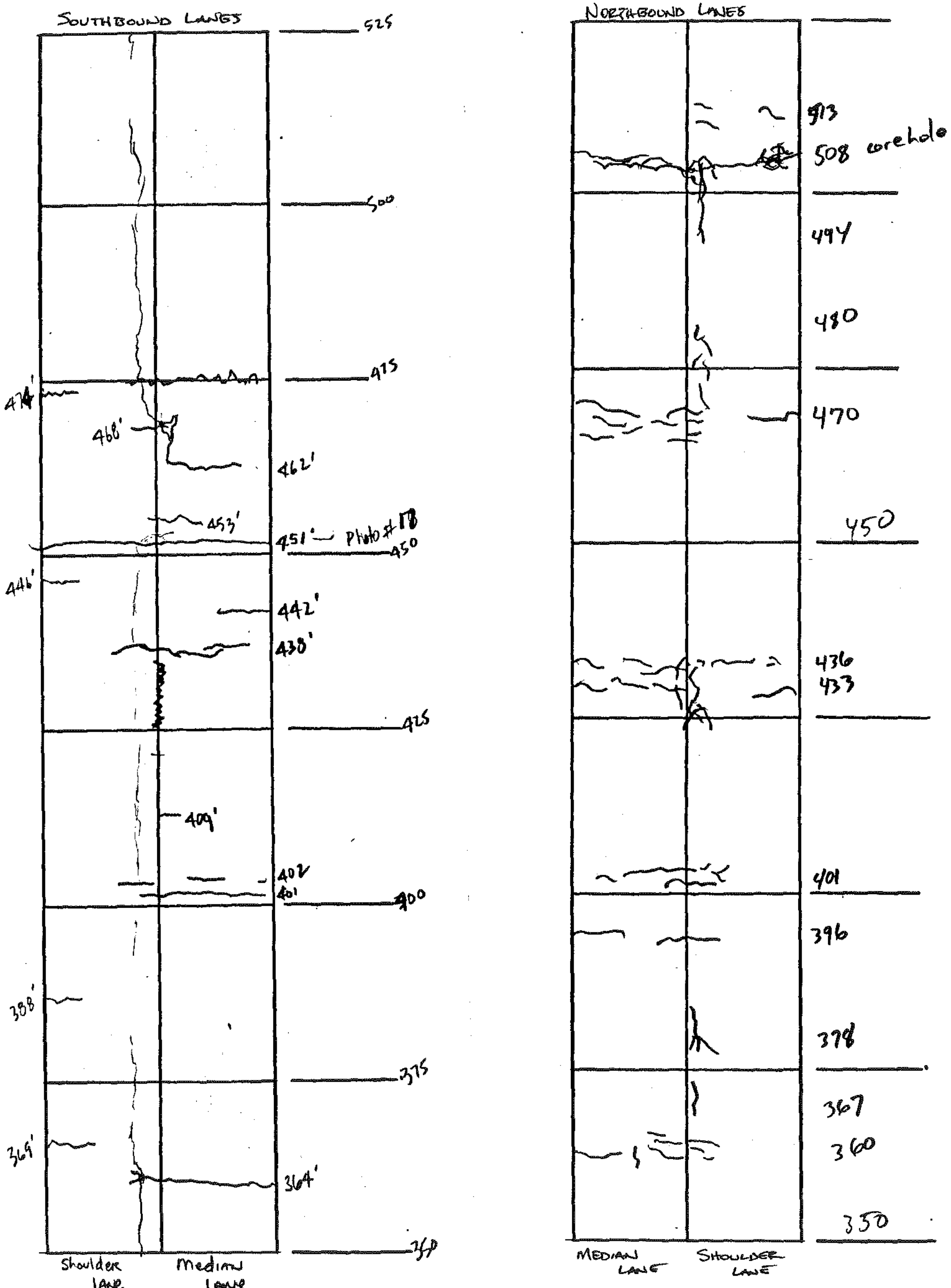


U.S. 23 GREENUP COUNTY

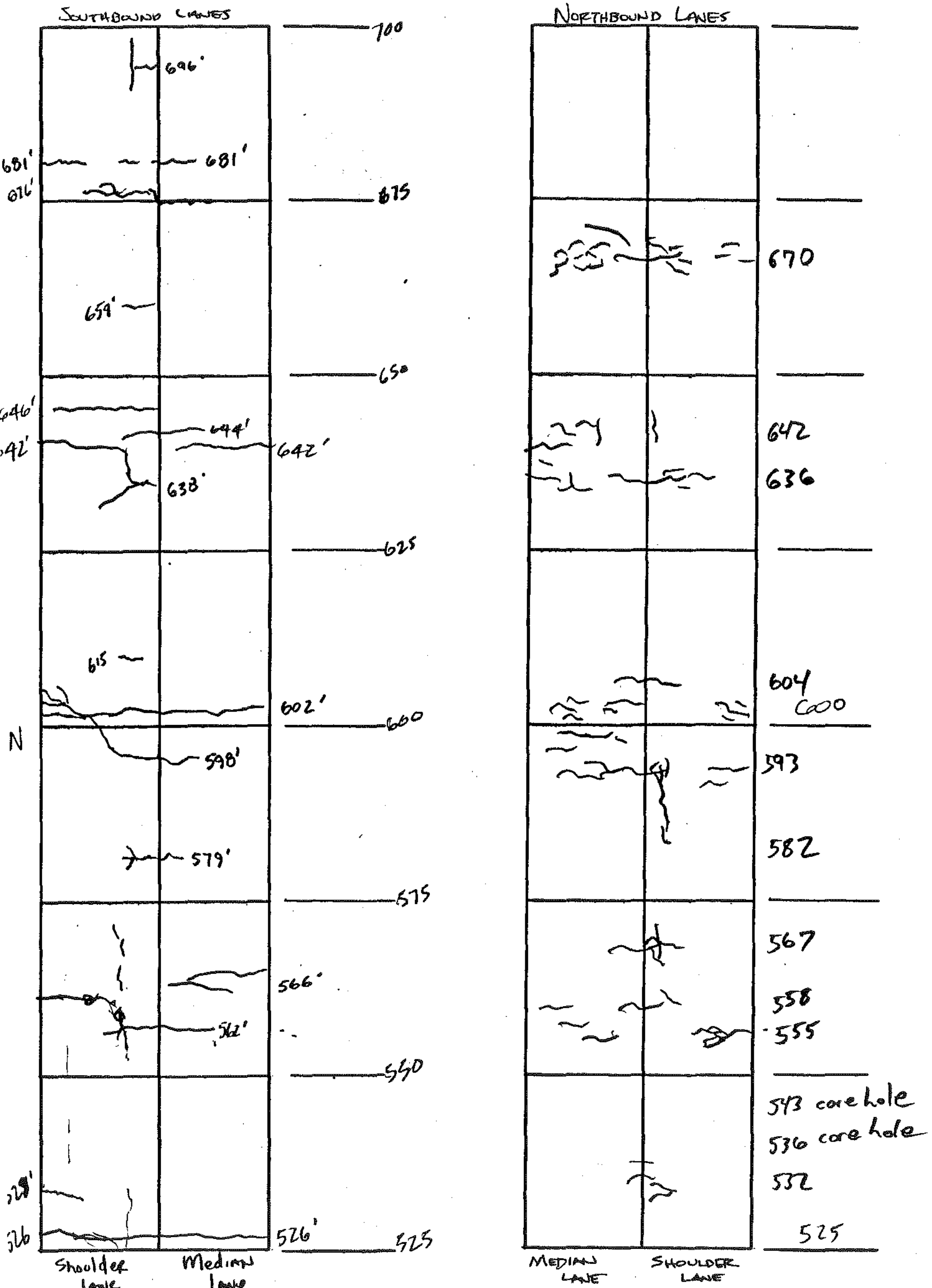
DESIGN SECTION J



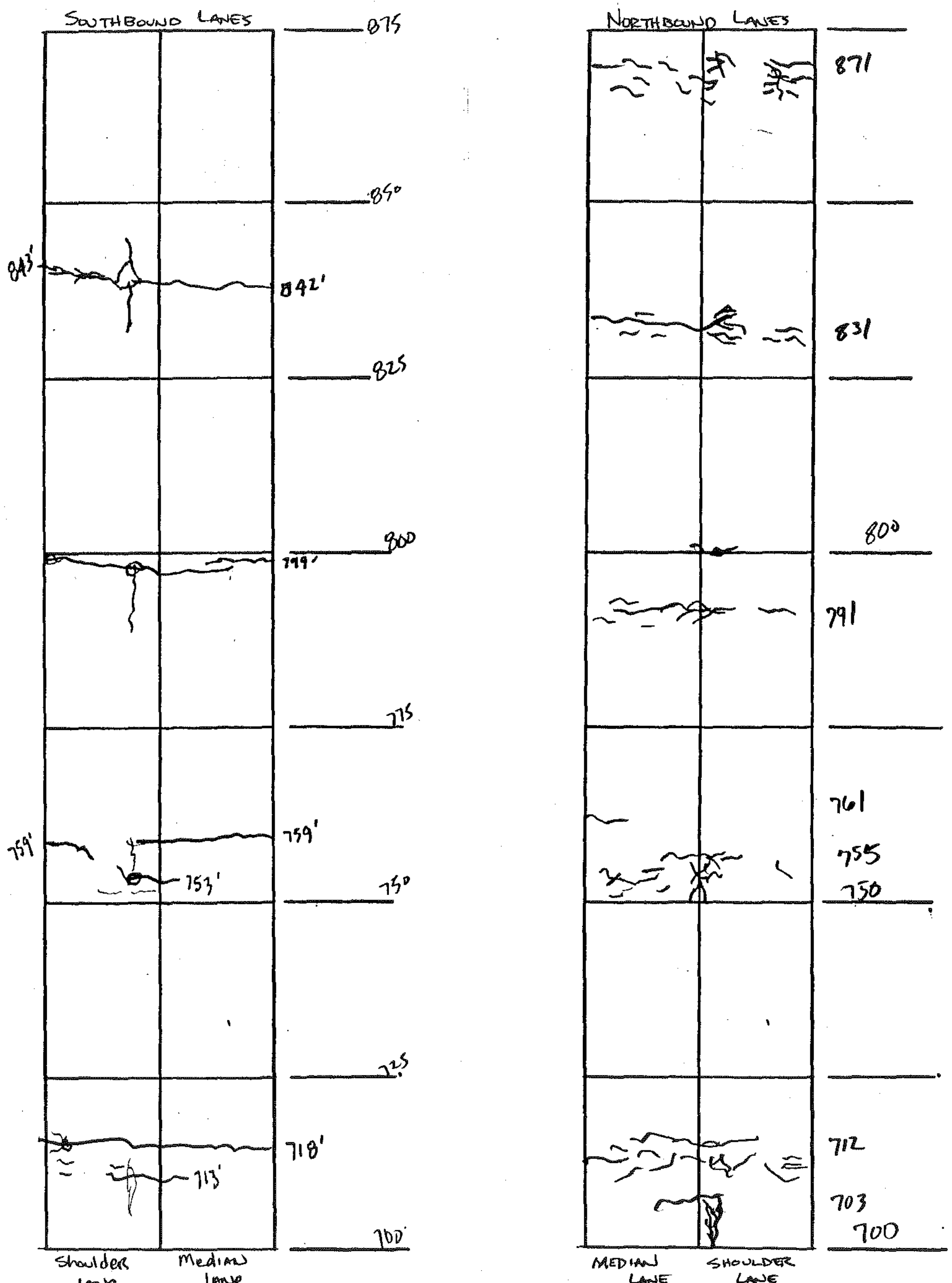
U.S. 23 GREENUP COUNTY
DESIGN SECTION J



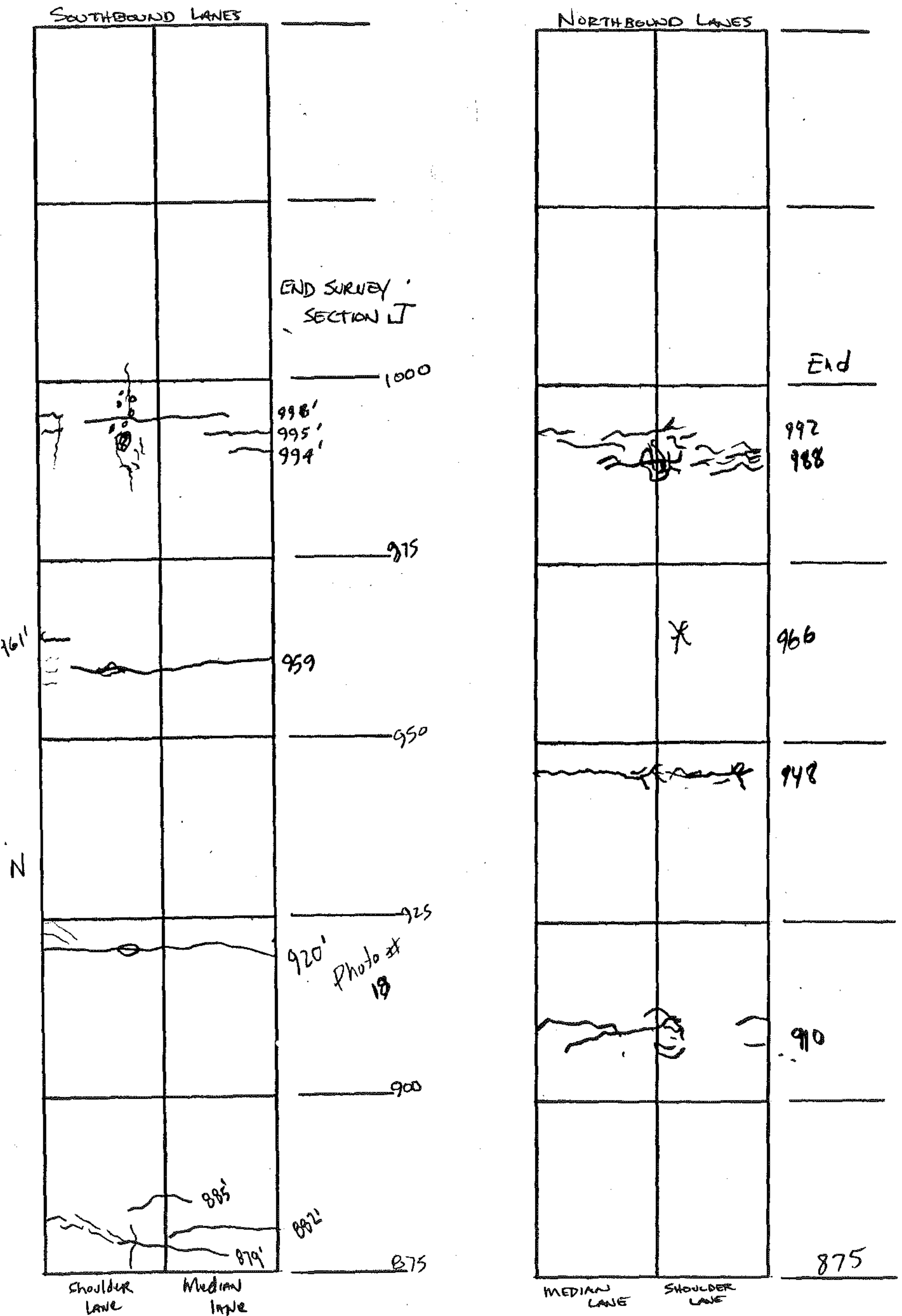
U.S. 23 GREENUP COUNTY
DESIGN SECTION J

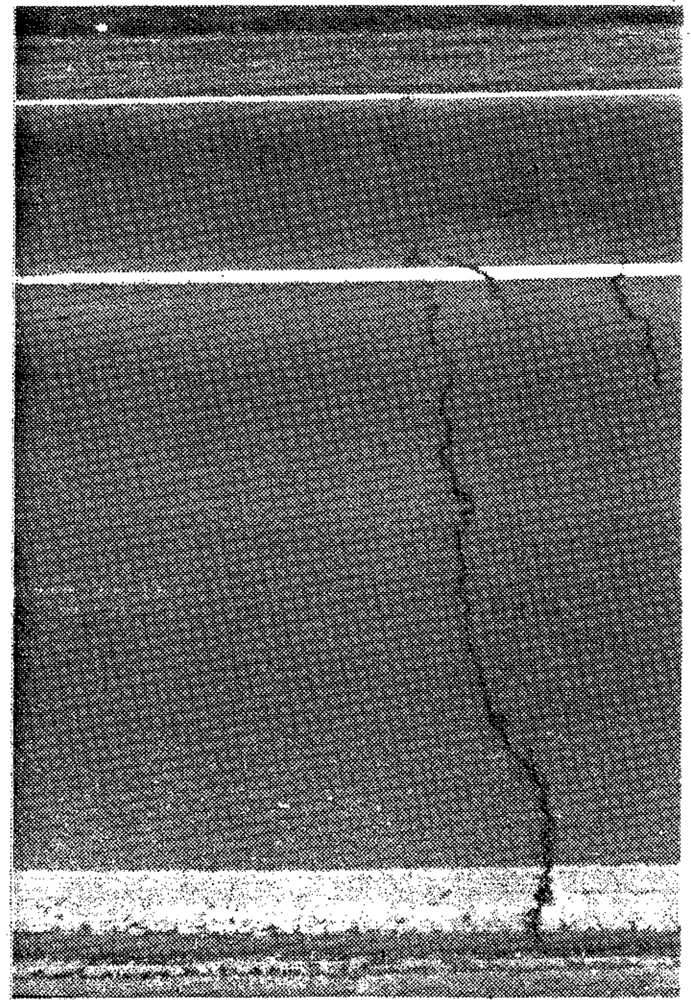


U.S. 23 GREENUP COUNTY
DESIGN SECTION J



U.S. 23 GREENUP COUNTY
DESIGN SECTION J





Section J - SB lanes at 451 ft.

Section J - SB lanes at 920 ft.

SECTION J Northbound MP. 28.0 to 28.0 + 1000 ft.

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
1			0+03	transverse	3'	
2			0+06	"	3'	
3			0+09	"	3'	
4			0+19	"	4'	
5			0+22	Alligator		4'
6			0+26	transverse	6'	
7			0+31	"	7'	
8			0+34	"	5'	
9			0+42	"	4'	
10			0+55	"	5'	
11			0+65	"	4'	
12			0+70	longitudial	4'	
13			0+74	transverse	4'	
14			0+78	"	8'	
15	0+81	0+97		longitudial	16'	
16			0+84	"	3'	
17			1+19	Alligator		30'
18			1+55	"		12'
19			1+66	transverse	8'	
20			1+73	"	12'	
21			1+79	"	5'	
22			1+89	Alligator		8'
23			2+02	transverse	6'	
24			2+18	longitudial	4'	

SECTION J Northbound MP. 28.0 to 28.0 + 1000 Ft.

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
25			2+22	transverse	5'	
26	2+30	2+60		longitudial	30'	
27			2+39	Alligator		24'
28			2+68	longitudial	3'	
29			2+75	transverse	18'	
30	2+75	2+96		longitudial	21'	
31			3+15	Alligator		36'
32	3+20	3+29		longitudial	9'	
33			3+47	"	4'	
34			3+60	transverse	14'	
35			3+67	longitudial	4'	
36			3+78	"	5'	
37			3+96	transverse	12'	
38			4+01	"	12'	
39	4+33	4+36		Alligator		54'
40			4+70	"		36'
41			4+70	transverse	6'	
42			4+80	longitudial	4'	
43	4+94	5+08		"	14'	
44			5+08	transverse	24'	
45			5+13	"	6'	
46			5+32	"	6'	
47			5+55	"	8'	
48			5+58	"	7'	

SECTION J Northbound MP. 28.0 to 28.0 + 1000 ft.

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
49			5+67	Alligator		18'
50	5+82	5+93		longitudial	11'	
51			5+93	transverse	10'	
52	6+00	6+04		Alligator		28'
53			6+36	transverse	10'	
54			6+42	〃	8'	
55			6+70	Alligator		30'
56	7+00	7+03		longitudial	3'	
57			7+03	transverse	6'	
58			7+12	Alligator		24'
59	7+50	7+55		〃		35'
60			7+61	transverse	4'	
61			7+91	〃	24'	
62			8+00	〃	6'	
63			8+31	〃	24'	
64			8+71	Alligator		72'
65			9+10	transverse	18'	
66			9+48	〃	24'	
67			9+66	Alligator		6'
68	9+88	9+92		Alligator		72'
				End		

SECTION J MP. 28 to 28+1000

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
1			0+01	Transverse	4	
2			0+05	Transverse	4	
3			0+05	Transverse	4	
4			0+43	Transverse	3	
5			0+42	Transverse	12	
6			0+45	Transverse	3	
7			0+45	Transverse	3	
8			0+45	Transverse	3	
9			0+50	Transverse	9	
10	0.0	0+51		Longitudinal	51	
11			0+76	Transverse	6	
12			0+84	Transverse	7	
13			0+88	Transverse	4	
14	0+75	1+50		Longitudinal/Aligat	75	24
15			1+15	Transverse	13	
16			1+23	Transverse	5	
17			1+27	Transverse	12	
18			1+40	Transverse	13	
19			1+59	Transverse	15	
20	1+58	1+70		Longitudinal	12	
21			1+66	Transverse	5	
22			1+79	Transverse	5	
23			1+92	Transverse	4	
24			1+94	Transverse	5	

SECTION 5 MP. 28 to 28+1000

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
25			1+96	Transverse	5	
26			2+00	Transverse	5	
27			2+00	Transverse	5	
28			2+14	" "	10	
29			2+22	" "	4	
30	1+75	2+24		Longitudinal	49	
31			2+37	Aligator/Transverse	9	4
32			2+40	Transverse	5	
33	2+38	2+54		Longitudinal	16	
34			2+45	Transverse	15	
35			2+50	Transverse	6	
36			2+53	" "	6	
37			2+77	" "	5	
38			2+76	" "	6	
39			2+77	" "	5	
40			2+78	" "	2	
41			2+79	" "	3	
42			2+87	" "	3	
43			2+91	" "	6	
44	2+87	3+07		Longitudinal	20	
45			3+00	Transverse	18	
46	3+01	3+14		Longitudinal	13	
47			3+15	Transverse	3	
48			3+16	Transverse	3	

SECTION MP. 28 to 28+1000

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
49			3+14	Transverse	4	
50			3+15	Transverse	4	
51	3+15	3+50		Longitudinal	35	
52			3+22	Transverse	4	
53			3+22	Transverse	7	
54			3+28	Transverse	4	
55			3+40	" "	18	
*56a	3+50	3+82		Longitudinal	32	
57			3+64	Transverse	14	
58			3+69	Transverse	5	
59			3+88	Transverse	5	
60			4+01	Transverse	13	
61			4+02	" "	4	
62			4+02	" "	4	
63			4+09	" "	3	
64	4+25	4+37		Longitudinal	12	
65			4+38	Transverse	12	
66			4+42	" "	6	
67			4+46	" "	5	
68			4+38	" "	4	
69			4+51	" "	24	
*56b	3+95	4+52		Longitudinal	57	
70			4+53	Transverse	6	
71			4+62	" "	7	

SECTION J MP. 28 to 28 + 1000

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
72	4+62	4+69		Longitudinal/Aligator	7	6
73			4+68	Transverse	4	
74	4+68	5+13		Longitudinal	45	
75			4+74	Transverse	4	
76			4+75	" "	13	
77	5+22	5+28		Longitudinal	6	
78			5+26	Transverse	24	
79			5+28	Transverse	5	
80	5+30	5+59		Longitudinal	29	
81			5+62	Transverse	13	
82	5+55	5+63		Longitudinal/Aligator	8	8
83			5+64	Transverse/Aligator	7	4
84	5+66	5+70		Longitudinal	4	
85			5+79	Transverse	6	
86	5+98	6+02		Drifing Transverse	14	
87			6+02	Transverse	24	
88			6+02	Aligator		16
89			6+15	Transverse	3	
90	6+33	6+38		Drifing Transverse	6	
91a			6+42	Transverse	9	
91b	6+38	6+42		Longitudinal	4	
92			6+42	Transverse	11	
93			6+44	" "	10	
94			6+46	" "	11	

SECTION J MP. 28 to 28+1000

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
95			6+59	Transverse	4	
96			6+75	" "	6	
97			6+76	Transverse/Aligator	7	6
98			6+81	Transverse	5	
99			6+81	" "	2	
100			6+81	" "	4	
101	6+93	6+99		Longitudinal	6	
102			6+96	Transverse	3	
103			7+13	" "	7	
104	7+05	7+16		Aligator		22
105			7+15	Transverse	2	
106			7+13	" "	2	
107			7+15	" "	2	
108			7+18	" "	24	
109			7+18	Aligator		6
110			7+52	Transverse	5	
111a	7+53	7+59		Longitudinal/Aligator	6	4
111b			7+53	Transverse	5	
			7+59	Transverse	6	
113			7+59	" "	14	
114	7+80	7+98		Longitudinal	9	
115			798	Transverse/Aligator	19	8
116			7+99	Transverse	7	
117	8+33	8+47		Longitudinal/Aligator	14	8

SECTION J MP. 28 to 28 + 1000

DISTRESS NUMBER	STATION FROM	STATION TO	STATION AT	DISTRESS TYPE	LENGTH OF DISTRESS (FT.)	AREA OF DISTRESS (SQ.FT.)
118			8+42	Aligator/Transverse	24	6
119			8+79	Transverse/Aligator	18	8
120	8+75	8+82		Longitudinal	7	
121			8+85	Transverse	5	
122			9+20	" "	24	
123			9+20	Aligator		4
124			9+22	Transverse	3	
125			9+25	Drifting Transverse	4	
126			9+59	Transverse/Aligator	22	4
127			9+57	Transverse	2	
128			9+59	Transverse	2	
129			9+61	" "	3	
130	9+87	9+94		Longitudinal	7	
131	9+92	9+95		" "	3	
132			9+95	Aligator		4
133	9+93	9+96		Longitudinal	3	
134			9+95	Transverse	2	
135			9+97	" "	2	
136			9+96	" "	16	
137			9+94	" "	4	
138			9+95	" "	6	
139	9+96	10+0		Longitudinal	4	
140	9+95	10+0		Several Potholes		6